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CIRCULATION THIS ISSUE
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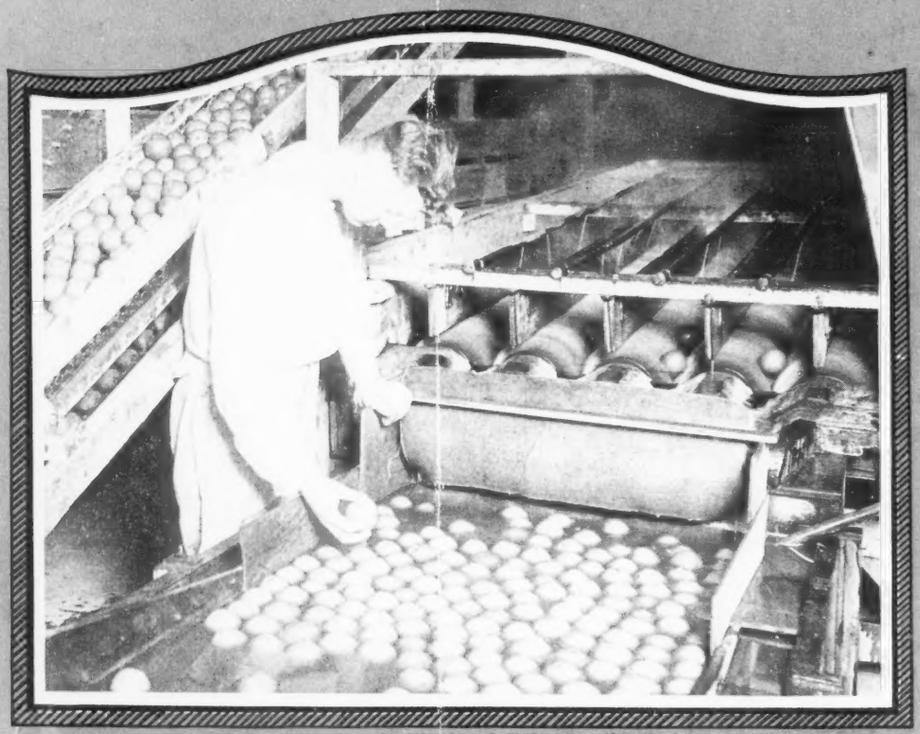

EACH ORANGE IS WASHED WITH WARM WATER AND SCRUBBED WITH SOFT BRUSHES BEFORE BEING DRIED WITH CURRENTS OF AIR.

California Gives Us Oranges the Year Round
Sidney Mornington

Long Tunnel Completed for Norway Power Company
J. S. Meehan

Bingham Canyon's Great Copper Camp
R. G. Skerrett

Producing Granite Paving Blocks on a Large Scale
Thomas Wentworth

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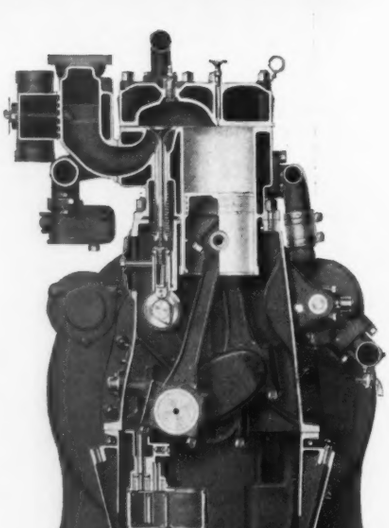
true character revealed

BEFORE any connecting rod is put into a Waukesha engine it is "right." After leaving the forge shop each rod is subjected to the *special deflection test.* Even the most minute defect, either in heat treatment or quality of material, cannot "get by." It was Waukesha engineering ingenuity that devised this simplest and most positive test... that definitely determines the fitness of a connecting rod to stand the stress of heavy duty in the modern industrial engine. *Waukesha connecting rods stand up.*

Bearing distortion is also eliminated. The reinforced connecting rod caps are heavily ribbed and held in place by four big, special heat treated bolts. Besides this great bearing stiffness, the large end of the connecting rod is ground to fit the removable bearing. Many other reasons for the long life of Waukesha engines are given in Bulletin 556. Write *Industrial Equipment Division, Waukesha Motor Company, Waukesha, Wisconsin. Offices: New York, 8 West 40th Street; San Francisco, 7 Front Street.*



Cross Section of 4-Cylinder Super-Duty Waukesha Engine

978

WAUKESHA ENGINES

As It Seems To Us

PAN-AMERICAN HIGHWAYS

A GOOD roads enthusiast, lately returned from an extensive trip through South America, prophesies that it won't be many years before it will be possible to motor from any section of the United States into the very heart of South America. While it would probably be unwise to accept this prediction without reservations, still a very considerable percentage of the populaces of the associated Americas would welcome the consummation of such a system of highway intercommunication.

As is well known, motor vehicles are gaining wider and wider recognition in the Western Hemisphere; and it is inevitable that they will displace conveyances drawn by draft animals more and more as roads are constructed upon which motor trucks and motor cars can move with greater rapidity and with less wear and tear than now occurs in the majority of the countries lying to the south of us. In short, the need for better roads will become insistently apparent, as it has done in our own case, directly in proportion to the purchase and the use of motor vehicles in any district or territory. Already response of this sort is being manifested increasingly in Mexico, in Central America, and in South America. Construction costs that would have deterred governments in the past have been greatly altered through the development of labor-saving machinery; and the roadbuilder has at his disposal today equipment that will enable him to do rapidly and at a comparatively moderate outlay work that would have staggered him a decade ago.

There is a well-supported campaign to promote in the Americas greater international intercourse through the medium of interlinking highways; and we heartily endorse this movement that is fraught with the possibilities of much reciprocal good.

ATHENS NEW WATER SYSTEM

ATHENS has today, thanks to American engineering skill, a water-supply system that bids fair to revolutionize not only the hygienic status of that ancient city but to make a very substantial monetary return to those persons or concerns that provided the needful funds to make this municipal improvement.

The *New York Times* calls attention to the fact that the undertaking is notable both because of its historic and its engineering character. The water for Athens is taken from the famous Plains of Marathon; and in creating the present system the constructors utilized an aqueduct built 2,000 years ago by the Roman Emperor HADRIAN. The work done by the Roman engineers was in so excellent a condition after the many intervening centuries that the Americans had only to patch it in places to render it capable of serving as a unit in the new system of water distribution. Surely, those ancient technicists builded well.

What American engineers and American equipment have accomplished in behalf of the people of Athens is but one more example of what can be achieved through the employment of modern methods and means; and it is a matter of satisfaction to us that compressed air has contributed its very helpful part in carrying forward to a rapid completion Athen's up-to-date system of water supply.

A GOLDEN HARVEST

GROWING citrus fruits in California forms the subject matter for the leading article in our current issue. The story is a heartening one because it reveals how American enterprise, resourcefulness, and research have created a splendid industry from a truly small beginning. The Golden State now ships annually a total of substantially 60,000 carloads of oranges, lemons, and grapefruit; and by the judicious cultivation of two outstanding types of oranges, California is able to provide millions of us with fresh oranges the year round.

Florida, on her part, is the annual source of quite 40,000 carloads of citrus fruits. The American people as a whole are especially indebted to the two states mentioned for these delectable, health-giving products that are now to be had the country over at a relatively modest cost. It is highly likely that the great majority of the people so benefited knows little if anything about what has been done by the growers to make this possible. We purposely draw attention to these particulars in order to emphasize our dependence upon the industry and to make clear why it is necessary for the Government to provide ample funds to combat destructive molds and insect pests that might all too quickly injure or even ruin orchards that produce crops totaling in value something more than $200,000,000.

The present status of the citrus-fruit industry in California is, in the main, due to well-directed coöperative marketing that has changed the economic outlook for the participants from a state of periodic uncertainty to one that annually brings in a substantial assured return. It represents a successful solution of one of the varied aspects of manysided agriculture in the United States.

MONKEY BUSINESS

IT MAY interest many to learn that Yale University has received a gift of $500,000 that will be spent in the course of the next decade in intimately studying groups of anthropoid apes that are to de domiciled on an expansive farm in Florida. The purpose, so we are informed, is to trace to prehistoric simians the responsibility for some of the traits that still persist in the juvenile and the mature of the human race. These researches are to be a source of material aid to the scientific staff of the recently organized Institute of Human Relations at Yale University.

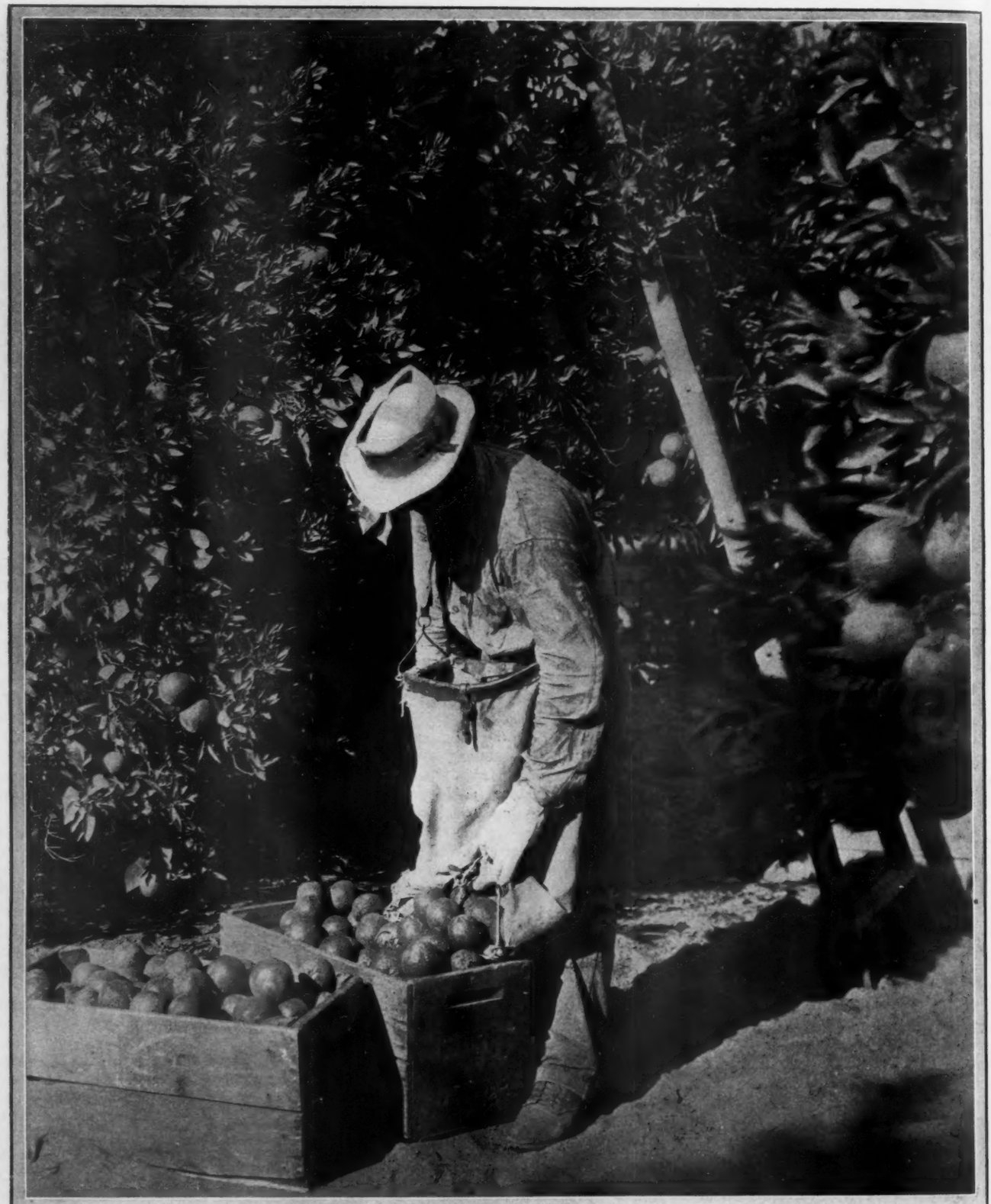
We do not know how some earnest fundamentalists will look upon this rather costly experiment; but we feel convinced that the investigators will find in the antics of those corralled apes much to remind them of the conduct at times of certain of their fellowmen. "Monkey business", as a colorful term for human behavior on occasions, is not just an accidental choice of words—it undoubtedly rests upon actions that have continued since the very remote past when vocal criticism had its beginning in the race.

MADAME CURIE HAS VISITED US AGAIN

HOW universal is the recognition of genius was once more verified when Mme MARIE SKLODOWSKA CURIE was recently given a sufficient sum by an appreciative group of American women wherewith to purchase a gram of precious radium. This was the second occasion upon which women of this country gave this eminent researcher a gram of radium. As upon that former presentation, Madame CURIE accepted the gift in trust only that she might pass the wonder-working mineral on to an institution that can utilize it in perpetuity in doing incalculable good to the physically suffering of humankind.

Our readers do not have to be told that Madame CURIE and her late husband conjointly, after protracted and infinitely patient investigation, discovered radium; and by so doing gave a fresh impetus to scientific thought and research and placed in the hands of competent members of the medical fraternity a therapeutic medium of amazing potentialities. The rays emanating from this age-old store of restless energy are, in effect, a multitude of infinitely small blades capable of doing curative work that would defy the operative skill of the most finished surgeon. Women especially have been helped by radium in circumstances where the use of the knife would have been prohibitive or perhaps fatal.

It was only a few years ago that radium cost $110,000 a gram; but happily the same quantity can be purchased for less than half that sum today. In the entire world, so it is said, the amount of radium in use does not exceed 350 grams—somewhat less than a troy pound; and yet this small quantity has already done a great many astonishing things that merely hint at the marvels that may yet be brought to pass by means of this remarkable substance.



GARNERING THE GOLDEN HARVEST

The oranges are picked by trained men, wearing gloves, who take every care to avoid bruising the fruit.

Oranges the Year Round

By SIDNEY MORNINGTON

ORANGES the year round! Fresh oranges and an abundance of them, full of appetizing flesh and health-giving juice. Such is the boon enjoyed by the people of the United States largely because of the citrus-fruit industry of California.

How many of us are familiar with the history of this amazing horticultural accomplishment which means so much to virtually all of us? The story is, indeed, a fascinating one, revealing as it does how this great industry has grown through the impetus given it by two small trees transplanted to California nearly threescore years ago.

In order that we may evaluate what those two alien trees meant to the Golden State, let us scan broadly the splendid proportions of citrus-fruit culture in present-day California. While this includes the growing of grapefruit and lemons as well as that of oranges, still the orange laid the foundation for the whole business. All told, the state has more than 197,500 acres planted with orange trees, and most of these are of fruit-bearing age. The annual crop fills more than 25,000,000 boxes; and these require approximately 55,000 cars to move them hither and thither to their far-flung markets. If we add to the foregoing acreage the areas covered with lemon and grapefruit trees, we get an aggregate of 254,000 acres devoted to citrus-fruit culture in California. Substantially 200,000 of the state's population are gainfully employed in the industry. All this has come to pas because of a freak of nature that brought into being in the Brazilian village of Bahia, a little over a century ago, an orange tree that developed a limb sport bearing seedless oranges characterized by a peculiar external formation that won for them the appellation of Navel oranges. That sprout grew on a Selecta orange tree, which was the favored variety at that time.

The new oranges made an immediate appeal to the Brazilian public; and commercial growers in the neighborhood of Bahia promptly set about propagating the seedless variety as rapidly as possible. In those days travel between Brazil and the United States was less frequent than now; and it was not until 1868 that William Saunders, in charge of the propagating gardens of the United States Department of Agriculture, learned about those superior oranges from a correspondent in Brazil.

As soon as he could do so, Mr. Saunders obtained a number of little Navel orange trees; but all were dead when they reached Washington after their long and round-about voyage. In 1870, however, a dozen of the small trees arrived in fair condition in the National Capitol; and from those buds were grafted on vigorous domestic orange stocks. They thrived, and in 1873 two of the young trees were sent to Mrs. Eliza C. Tibbets, then residing at Riverside, Calif. Two years previously, an enterprising Tennesseean planted with orange sssds a very considerable area of desert land where the City of Riverside now flourishes. At that time the accepted practice was to grow orange trees from seed, despite the variations from parent type displayed by such seedlings.

Subsequently, seedling stock was supplanted by budded stock; but not before the pros and cons of that method of propagation had been thoroughly aired. The advocates of seedlings argued that budded stocks were at best only sports of uncertain life and, owing to their smaller stature, likely to be less productive. But there were Mrs. Tibbets' trees to disprove some of these contentions by their abundant fruitfulness. During the dry months Mrs. Tibbets watered her little trees with dishwater; and she nursed them most carefully during their early, tender years. Inevitably, the Navels won increasing recognition; and it was not a great while before actual and prospective growers were desirous of planting their orchards with that stock. Today, a bronze tablet commemorates Mrs. Tibbets' service to her state; and there are the best of reasons for calling her the "Mother of the California Citrus Industry".

One of Mrs. Tibbets' two parent Navel orange trees securely fenced in to safeguard it from souvenir hunters. This tree is now more than 50 years old and still bears fruit.

There is a widespread but mistaken belief that California's orange groves have developed from trees planted by the Franciscan Fathers at their missions, which were established at points from San Diego northward. Such is not the case, however, because the orchards created by those spiritual pioneers declined rapidly and, in some in-

stances, entirely disappeared after the missions were secularized in 1834. Accordingly, the present industry had its beginning later on, and was not a really promising field of endeavor until after the Navel orange gained favor with the public and the growers.

Navel oranges are associated with the Christmas season, because then it is that millions of them flow to our markets in their luscious golden abundance. The Navel orange ripens so that it can be picked, packed, and distributed from November of one year until May of the succeeding year. This fact has caused many people erroneously to conclude that oranges bought later on are cold-storage fruit. The California grower has met nature halfway by cultivating the Valencia orange, which matures so that it can be marketed from May to November of any year—the Valencias and the Navels together enabling California producers to give us fresh oranges the year round.

Seldom does rain fall during the summer season in California. Orchards must, therefore, be irrigated by distributing water through ditches plowed between the rows of trees.

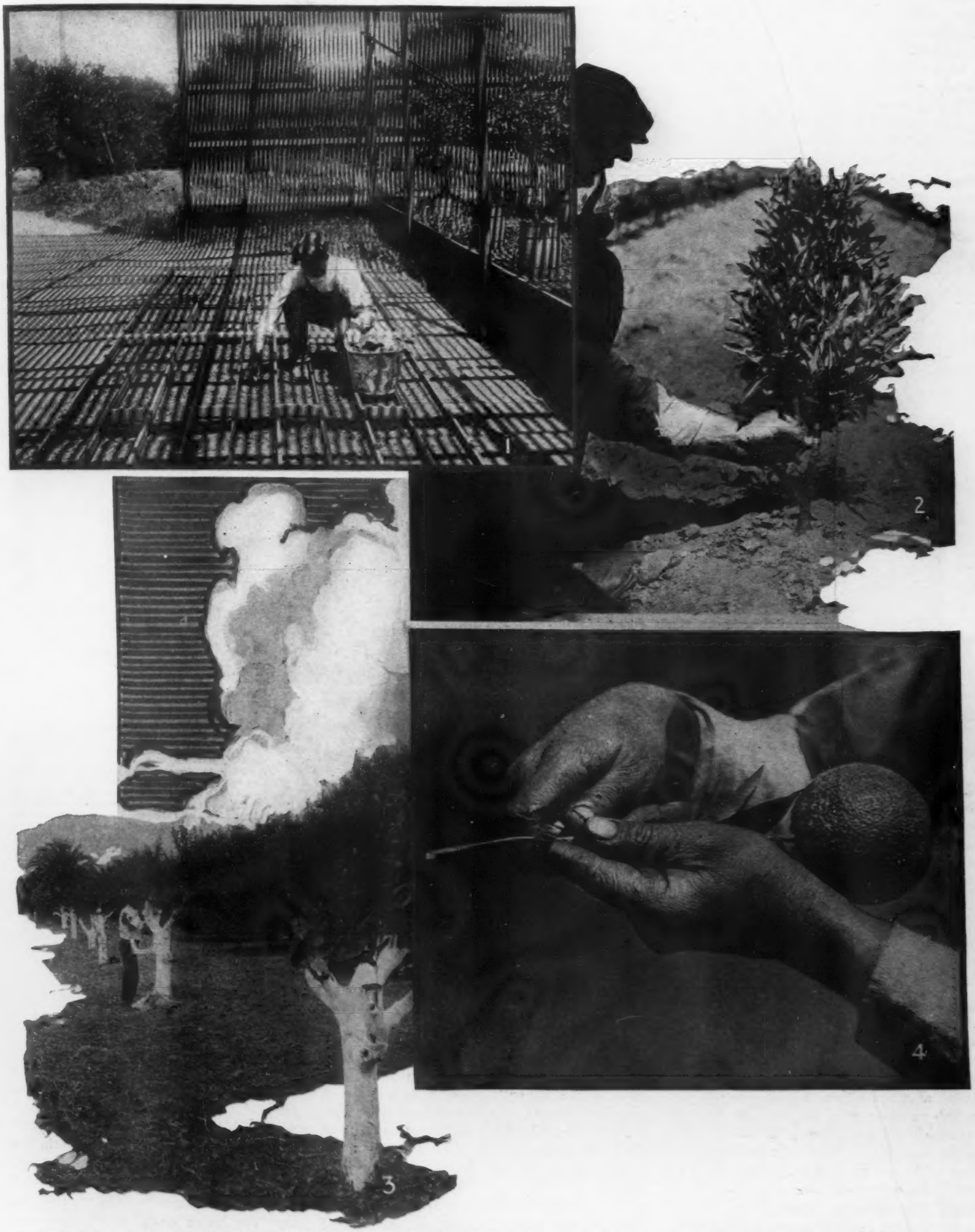
The Valencias originated in the Azores, and were brought to our shores about the same time that the first Navel orange trees were imported from Brazil—thus Portuguese growers were responsible for both varieties. The earliest Valencia orange trees were planted in California around 1872; but their propagation on a considerable commercial scale was held back for many years. The seedless character of the Navels led to the neglect of the really excellent and nearly seedless Valencias; and this attitude of the majority of the growers bade fair to make the industry onesided and essentially seasonal. Fortunately, some of the citrus growers awakened to the unwisdom of that course, and urged their associates to cultivate both kinds so that they could supply the market throughout the whole twelvemonth. Then it was that the Valencias gained the recognition to which they were entitled.

It so happens that the Valencias can best be grown in the cooler coastal regions of California, while the warmer inland valleys are especially suited to the cultivation of the Navels. The summertime in the San Joaquin Valley of central California is notably warmer than other sections; and there it is that the Navels ripen earliest. It is from that part of the state that so much of the rest of the country obtains its California oranges during the Thanksgiving and the Christmas holidays.

The utmost care is exercised at every stage in growing California citrus fruits; and the work is carried on efficiently and scientifically so as to make the most of the stocks' inherent virtues and also to guard the trees against harmful diseases peculiar to their kind. The primary aim is to obtain seedling trees from rootstocks of established hardiness. The seeds are planted in closely spaced rows beneath sheltering lath lattice; and the little trees that come from the seed are left undisturbed until they have attained a height of about 12 inches. These seedlings are scrutinized, and the most promising of them are taken up and set out in rows in a nursery where they remain for a year or two to gain desired altitude and strength. They are then ready for budding or grafting, as the procedure is generally known.

The buds for this purpose are cut from older bearing trees, and they are chosen from pedigree stock. The choice is not a matter of

Some of California's orange groves are in their fruitful prime when the mountains in the background are still capped with snow. "Sunkist" oranges are gathered with great care by pickers wearing cotton gloves and equipped with dull-pointed clippers.



1—Orange trees are sprouted from hardy seed sown in the shade of large lath sun-shelters. 2—A seedling tree that has been budded with pedigree stock. The wounded trunk is carefully wrapped with waxed tape. 3—These lemon trees are being budded over to oranges with pedigree buds from which will spring new growths bearing oranges like those of the parent trees from which the buds were taken. 4—Orchardist preparing a bud from a pedigree orange tree for grafting on to other rootstock.

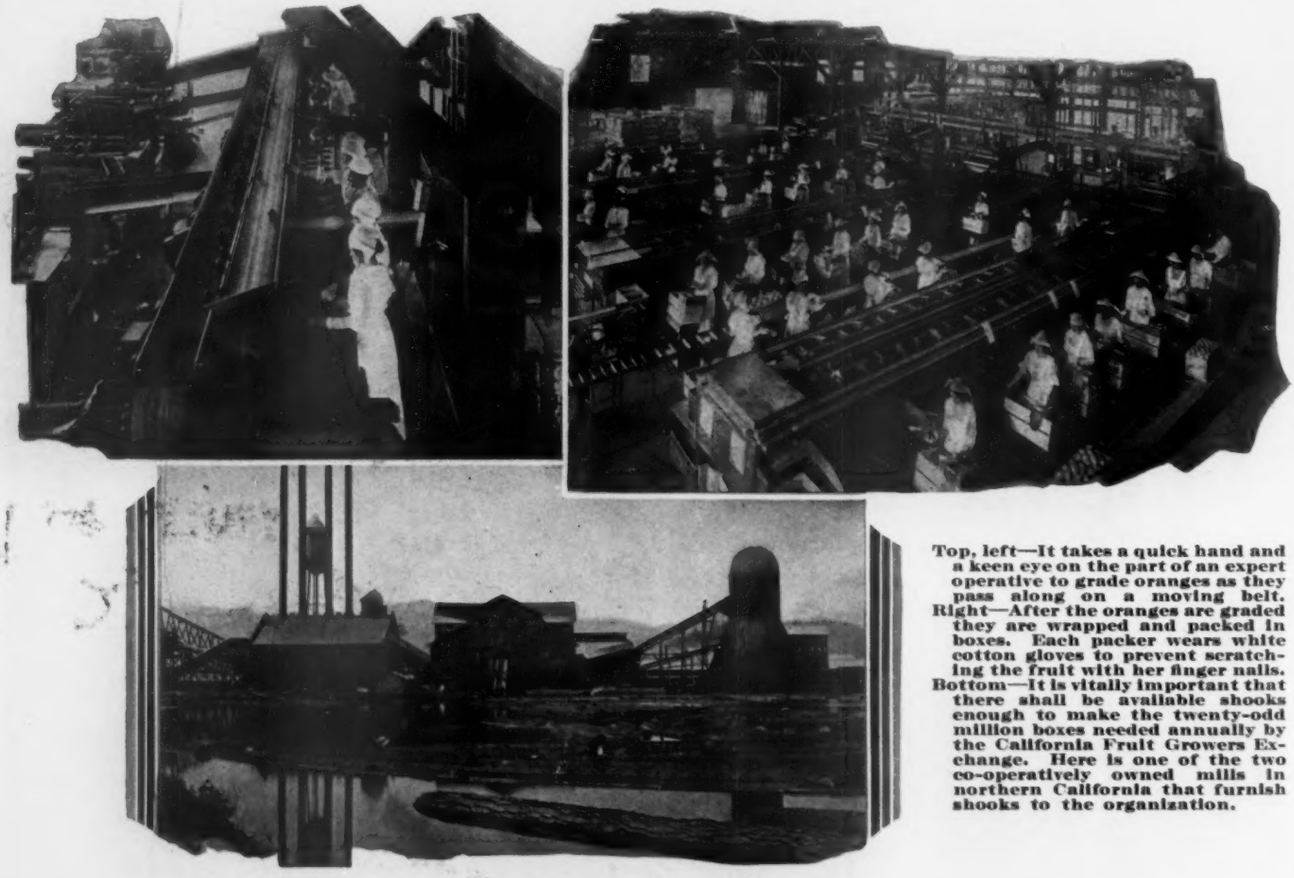
guesswork but of exact knowledge, because every up-to-date grower keeps a complete record of every tree in his orchard and registers all its essential characteristics. That is to say, he knows the kind, size, color, and flavor of the fruit grown on each tree, and whether or not it ripens early or late. Also, he notes the vigor of the tree and its ability to resist disease. The chosen buds are inserted in slits made in the bark of the small trees about 4 inches above the ground, and they are held in place with wrappings of tape. One bud is grafted to each tree; and if the bud "takes", it grows into a shoot that is trained so it becomes the top of the little tree—the original top of the rootstock tree being cut off.

The newly budded tree remains in the nursery for a year before it is set out in a grove; and, generally, there is a period of three years between the planting of the seed for rootstock and the placing of the grafted tree in an orchard. The curious thing about this method of propagation is that the budded tree will produce only the fruit of the tree from which the graft came, no matter what kind of rootstock is used. In other words, orange buds may be inserted in grapefruit or lemon rootstock, and the trees will bear oranges. Conversely, lemons or grapefruit may be made to grow upon orange rootstock.

Many growers, when they find that they have trees that do not produce good fruit, or enough of it to pay for the care required, amputate the limbs and rebud the remaining trunk with buds from trees that have records of good fruit and abundant yields. The trees are arranged symmetrically in rows to facilitate easy irrigating and cultivating in four directions; and, usually, from 76 to 100 trees are planted to an acre. Such a grove will bear commercial crops of fruit in six years. Production increases as the trees grow; and a grove is considered at full-bearing age when ten years old. However, if properly cared for, the trees will yield larger and larger crops for many years following.

During the dry season the groves are irrigated regularly every three or five weeks; and the amount of water supplied in this way is determined after testing the moisture of the soil. From time to time the trees must be pruned to insure a suitable disposition of the foliage; and once every twelve months the trees are covered with canvas tents and fumigated after nightfall with hydrocyanic-acid gas to kill a scale-inducing insect. Citrus trees are occasionally sprayed to dispose of other insect pests. For this purpose a machine is used provided with a tank containing from 300 to 400 gallons of the necessary germicide. A hose-and-nozzle attachment, with air pressure, blows a fine vapor-like spray over every part of a tree's foliage. Damaging frost is prevented by placing oil-burning heaters at suitable points throughout an orchard—the resulting smoke forming a protective cloud or blanket above and about the trees.

When ripe enough to harvest, the fruit are gathered by trained pickers who move from grove to grove. The oranges are not pulled: they are cut off, one by one—the pickers wearing gloves and using every precaution not to injure the fruit's skin in any way, lest decay set in. The clipped stem must not be left long, because it might puncture the skins of other oranges touched during picking and boxing. Similarly, care must be exercised to prevent the tree branches from scratching the fruit during removal. The pickers place the oranges in special sacks that unbutton at the bottom and thus permit the contents to roll gently into field boxes particularly designed for the purpose. These boxes are now and then dipped in an antiseptic solution to kill the germs of decay that may be clinging to them. Because oranges and lemons are handled as carefully as eggs, millions of dollars worth of the fruit are saved yearly that might otherwise be lost through decay.



Top, left—It takes a quick hand and a keen eye on the part of an expert operative to grade oranges as they pass along on a moving belt. Right—After the oranges are graded they are wrapped and packed in boxes. Each packer wears white cotton gloves to prevent scratching the fruit with her finger nails. Bottom—It is vitally important that there shall be available shooks enough to make the twenty-odd million boxes needed annually by the California Fruit Growers Exchange. Here is one of the two co-operatively owned mills in northern California that furnish shooks to the organization.

The field boxes are transported to the packing houses, where they are left to stand for a day or two to evaporate some of the moisture in the rind and thus render the skin less easy to injure. Afterwards, the fruit are thoroughly washed mechanically and then graded and packed by skilled workers who invariably wear gloves. The washed and dried fruit are borne along on an endless canvas belt before the graders, who examine each orange or lemon carefully but quickly and separate it into its proper class according to specified requirements. This grading has

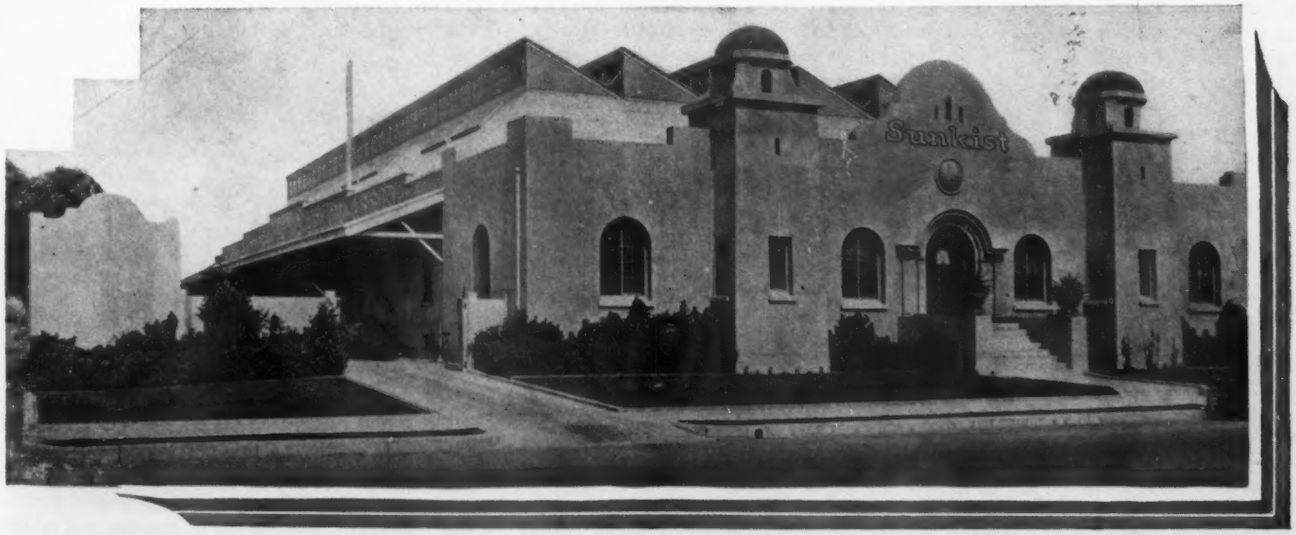
Left—An orange tree bearing fruit and blossoms at the same time. The springtime perfume of a California orange grove is indescribably delightful. Right—Lemon trees blossom throughout the entire year. Buds, blossoms, and fruit in all stages of development can be seen on a tree at the same time.

nothing to do with the size of the fruit. After grading, the fruit are moved by other belts to sizing machines that automatically dispatch the oranges or lemons to one or another of several canvas bins. Packers take the fruit from the bins, wrap them in tissue paper, and place them in the shipping boxes. An expert packer will fill from 50 to 75 boxes during a day. What this means can be better understood when we are reminded that a box will contain anywhere from 80 to 324 oranges or from 240 to 490 lemons—depending upon the size of the fruit. Many packing houses have refrigerating rooms where citrus fruits are thoroughly cooled before being loaded into cars; and some of them manufacture their own ice for the icing of the cars during the warmer months.

The foregoing details of the procedure followed among the majority of California's citrus-fruit growers is that prescribed by the California Fruit Growers Exchange, which markets 75 per cent of the citrus fruits produced in the state. This organization was the outcome of an unhealthy condition in the industry that reached its climax in 1893, when the state was shipping annually not more than 15,000 carloads of fruit. Today, this coöperative, non-profit organization is handling at a remarkably low cost substantially 60,000 carloads of citrus fruits every twelvemonth, and is doing a business valued, free on board, at nearly $100,000,000!

Based on the average cost of suitable land in California, outlays for water, fertilizer, and necessary care, a 7-year old orchard represents an expenditure of from $1,000 to $1,500 an acre. The things that must be done to maintain an orchard in a proper productive state require, probably, an outlay of from $200 to $300 an acre per year. Picking, hauling, and packing cost on an average 75 cents for each box of fruit; and the marketing service furnished by the California Fruit Growers Exchange, which ships the products, is generally about 7 cents a package. An astonishingly low charge for the splendid service rendered. The average yield per acre in California is between 150 and 200 boxes.

What has been said about the methods employed in the propagation of orange trees applies likewise to the lemon trees found on the 47,000 acres of lemon plantings in California. The utmost diligence and care are



It is from packing houses like this, placed at strategic points, that "Sunkist" oranges are marketed through the California Fruit Growers Exchange. There are 250 plants of this sort in operation.

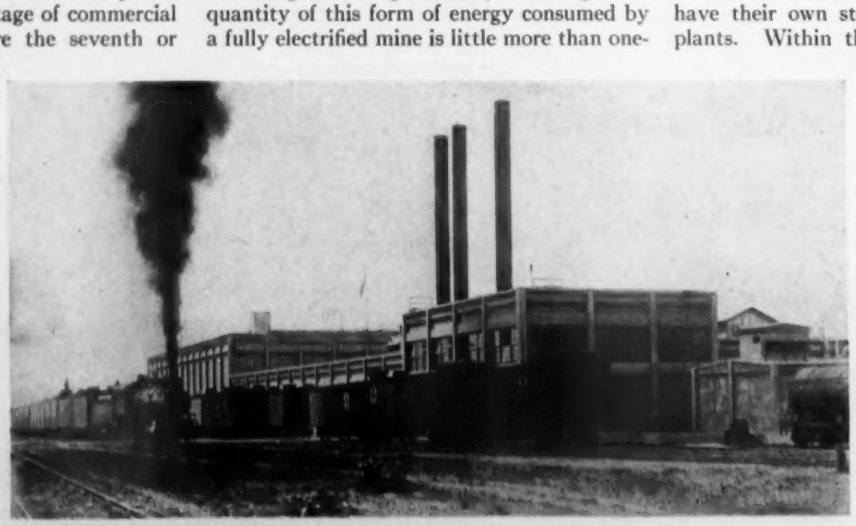
exercised in producing trees that will yield superior lemons that can be marketed at a profit. While it is true that the early Spanish pioneers brought the lemon to North America, the commercial development of its culture was much slower than that of the orange. Today, the varieties cultivated for the market are the Lisbon—believed to have reached California from Australia—and the Eureka, which originated in Los Angeles from Sicilian lemon seed. The southern part of California is the climatically favored section for the growing of lemons: and, according to the latest figures available, those for 1928, the crop amounted to 11,535 carloads. Substantially all the lemons produced in the United States are grown in California; and the state is the source of from 75 to 85 per cent of the lemons consumed in this country and in Canada—the remainder being imported from Italy. Italy and California together virtually furnish the world with lemons.

In a "Sunkist" packing house oranges are washed in warm, soapy water and scrubbed with soft brushes. Afterwards they are rinsed and then dried by currents of air.

Lemon trees produce continuously the year round; and, because of this, blossoms, green fruit, and ripe fruit can be found on a tree at the same time. It is due to this habit of the tree that a matured specimen will yield as many as 3,000 lemons in the course of a twelvemonth. As a rule, it costs more to bring a lemon grove to the bearing state than it does to achieve the same condition in an orange grove: and growers pay on an average $1.40 a box for picking, hauling, and packing the fruit for shipment.

Hardy orange rootstock is usually utilized for budding pedigree lemons. A lemon tree will bear some fruit at the end of four years; but it does not reach the stage of commercial production generally before the seventh or eighth year. Lemons are picked according to their size; and the best grades are gathered green in the same careful way that oranges are picked. The green fruit are put in storage rooms to cure—the temperature and the humidity being nicely regulated; and there the lemons acquire the waxy yellow color with which we are familiar.

Through the coöperation of the California Fruit Growers Exchange, the state's citrus industry has developed along highly scientific lines—the fruit being grown under conditions that exhaustive research has shown to be desirable. The subsequent picking, packing, and marketing are outstanding examples of efficiency applied to agriculture in disposing of delicate products in ways that result in an amazingly small percentage of loss between the grove and the consumer. Otherwise, it would be impossible for us to obtain oranges the year round and at the prices we pay for them today



Making up trainloads of California citrus fruits. When necessary, the cars are precooled; and many of the packing plants manufacture ice for this purpose.

COMPRESSED AIR IN SOUTH AFRICA'S GOLD MINES

IN an address on the power supply for South Africa's gold mines, delivered at the joint meeting of the British and of the South African Association for the Advancement of Science held during the past fall in Johannesburg, Mr. Bernard Price, general manager and chief engineer of the Victoria Falls & Transvaal Power Company, Ltd., had this to say regarding compressed air:

"Compressed air is an essential requirement of the gold-mining industry, although the quantity of this form of energy consumed by a fully electrified mine is little more than one-third of the power consumed in the form of electricity. The characteristics which render compressed air suitable for use underground are: its elasticity, which makes it an ideal medium for obtaining reciprocating motion and for producing the high percussive effect required for drilling hard rock; its capacity to absorb heat from the surrounding media when doing work, which makes it a valuable cooling agency; and its ventilating properties."

"Numerous machine drills are employed daily on the Rand for drilling rock underground. Compressed air is also used for operating hoists, pumps, drill-sharpening machines and power hammers, for ventilating out-of-way places, for foundry work, and for a variety of other services. In a few instances where mines have found it uneconomical to retain boiler plants for just operating hoists, the latter have been converted to air drive. In other instances air is used for pushing the cocopans and ore on to the tippling platforms, for opening and closing safety doors over shafts, and for similar auxiliary services. Once an unrestricted supply of compressed air is available, new uses for it continually arise. Unlike steam, an air supply involves little if any loss when standing by.

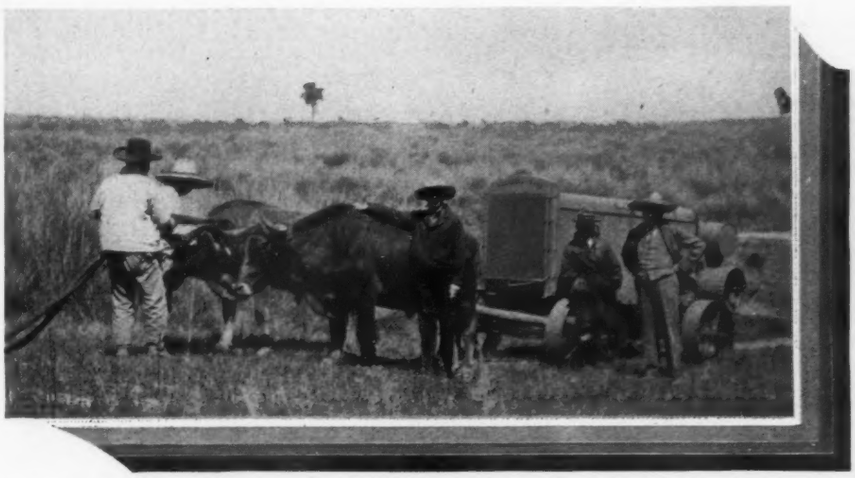
"The consumption of compressed air by individual mines per ton of ore milled varies widely. The average for mines taking supply from the power company is about sixteen air units per ton milled. Originally each mine obtained its compressed air from steam-driven compressors locally installed, and today those mines which are not situated within an area in the center of the Witwatersrand district have their own steam or electrically driven plants. Within this central area, however, supply is furnished in bulk by the Victoria Falls & Transvaal Power Company from a pipe system fed by two central compressing stations. This centralized compressed-air-supply undertaking is quite unique."

What will be one of the longest underground telephone cables in the East is now being run between New York and Albany, a distance of 150 miles. The work, which is being pushed from several points along the line, will take several years to complete.

Air-Driven Diggers Harvest Broom Root

By THE STAFF

VEGETABLE fibers of various sorts are used widely in brushes in place of much more expensive hog bristles. In fact, brushes for a diversity of purposes would be unobtainable but for the adaptability of certain vegetable fibers. Indeed, to the uninitiated some of these fibers appear to be bristles when set in brushes; and for the prices charged for them they do their work well and stand up in service reasonably long. This article has to do with vegetable fibers that flourish in Mexico—the product being variously known as broom root, rice root, and *zacaton*. The name rice root is a corruption of the Mexican appellation *raiz de zacaton*, which, literally translated, means root of the large grass.



Oxen haul the portable compressor from point to point to furnish motive air for the diggers.

According to experts in the United States Department of Agriculture—to whom we are indebted for much of our information—the plant, itself, is a bunchy grass having the botanical name *epicampes macroura*. It grows wild on the high mountains of central and southern Mexico and extends thence into Guatemala. It is notably abundant in the Sayula region, west of Mexico City, and in the Toluca district on the slopes of Mount Orizaba, east of the capital.

American manufacturers of brushes have used broom root for years; and heretofore all their supplies have been harvested in a laborious and somewhat primitive fashion, and generally by Indians. The plant has a firm hold upon the ground—its roots penetrating deeply into the sustaining soil; and in order that we may be able to properly evaluate the procedure that is now followed by some up-to-date landowners, let us describe the native method of digging it out. For this purpose the Indians use a large wooden lever pointed at one end and about 10 feet long. After loosening the earth around a clump, they drive the pointed end under the mass of roots and pry it free. The roots have a diameter of about 1/16 inch, and range from 20 to 30 inches or more in length. The blades of grass grow in a dense cluster 10 to 20 inches across, and rise to a height of from 2 to 4 feet.

With the clump dislodged from the ground, the natives cut off the stiff grass with a hatchet or a *machete*. Afterwards the roots are taken to the nearest creek and washed to get rid of the clinging soil. Next, the roots are tied into bundles of from 88 to 176 pounds each. Two bundles constitute a load for a burro; and these little pack animals are widely used in transporting the raw stuff to central receiving agencies. The Indians who harvest the roots in this way are paid at a given rate per unit weight of roots—the price varying according to the cleanness, the length, and the quality of the product.

At the receiving agencies the roots are put in a large room where they are bleached with sulphur fumes; and after that they are washed, sorted, and bleached a second time. Finally, they are tied into bundles and pressed into bales for shipping. So treated, the marketable roots range from 5 to 20 inches in length—having been assorted agreeably to size, quality, and length. The fibers are canary yellow in color, very stiff, and are extensively used in the manufacture of scrubbing brushes. For a long while the roots were obtained from wild stock; but wide-awake growers in the State of Vera Cruz have recently started cultivating *zacaton*. As a consequence, they are obtaining roots that are superior in length and more uniform in quality than those from plants growing wild in the mountains.

Aside from the economic value of broom root, our interest in the subject is heightened by the much more modern procedure today employed in harvesting the raw material with the aid of pneumatic tools and air furnished by portable compressors. The accompanying pictures illustrate the way in which the digging is now done on the *hacienda* La Providencia

Pneumatic diggers have radically altered the long-existing method of harvesting broom grass, and are saving the industry much time and money.

Here are seen some of the various steps in the assorting and the drying of broom grass as practiced at the hacienda La Providencia.

near El Oro, in the State of Mexico. There, instead of using long, pointed poles to pry the grass loose, pneumatic diggers, equipped with 8 x 30-inch flat picks, are utilized. At the time of writing, a 10 x 8-inch Type 20 Ingersoll-Rand portable was providing the needful compressed air, and it had then been working eight hours a day continuously over a period of three months. In the course of an 8-hour shift it is thus possible to clear up an area of 600 square feet. With that accomplished, a double team of oxen is hitched to the compressor, drawing it to a new location with relatively little trouble, despite the weight of the machine and the softness of the ground.

Three men are detailed to each digger. One of them digs around the plant to loosen it and to pry it free; the second man beats some of the dirt from the roots; while the third one cuts the roots from the upper part of the plant. Before the pneumatic diggers were adopted, the men averaged 11 pounds daily when using the traditional pointed pole. At the present time, they average 77 pounds a day. The *hacienda* in question employs about 1,000 men in digging and preparing broom grass for different foreign markets; and this force, even with the aid of air-driven tools, is not able to fill all the orders from abroad. Nearly a score of the diggers are in service; and with these substantially 1,232 pounds of roots are harvested daily. Of this total, virtually half is dirt that is removed when the roots are washed. When dried, the roots are exposed to sulphur fumes for about fifteen hours; and after being assorted they are compacted into bales containing 110 pounds each. This work is done with hand presses. So baled, the fibers are shipped away in carload lots. No one seems to know exactly in how many ways the roots are utilized; but it is unquestionably true that these tough and stiff vegetable fibers serve admirably in many directions where bristles might otherwise be needed. Not only that, but they can be used to advantage for heavy work to which bristles would not be equal.

Hacienda La Providencia, near El Oro, Mexico.

PNEUMATIC CAISSON IN DUAL ROLE

TURNING a caisson temporarily into a diving bell was the expedient recently employed with success in leveling a shelving ledge of submerged rock on which to anchor one of the piers for the Vicksburg Bridge. To quote *Engineering News-Record:* Pier 3, which carries the east end of the cantilever span, is located on a reef, part of which is soft rock and the remainder a very hard clay. At low stage there were 30 feet of water and a fairly swift current in the river. In the 40-foot width of the caisson the reef had a slope of about 7 feet toward the channel. The river bed was very irregular, and the material was too hard to dig with a dredging bucket to level off the site for landing the caisson. Time did not permit the rigging up of a submarine drilling and blasting outfit, therefore the caisson itself was used as a diving bell.

Derrick stones were dumped into the low places, and the caisson was towed into position and concreted until its shoe floated just clear of the river bed. Sand bags were deposited around the outside, and the caisson was flooded with enough water to overcome the buoyancy developed by the air pressure. Compressed air was put on, and sand hogs worked inside leveling up the bottom and removing obstructions. This done, the air was taken off, the water ballast pumped out, and the caisson floated and sunk in the same manner as those for the other bridge piers.

Instances of this kind are unusual, but a caisson was similarly utilized by French engineers in bridging the Elorn at Brest. That caisson, however, was not anything like as large nor used at as great a depth as the one at Vicksburg.

SHIP-SALVAGE OPERATIONS AT SCAPA FLOW

THE raising of the vessels of the German fleet, sunk in Scapa Flow during the World War, is at present principally centered on the 5,000-ton cruiser *Bremse*, which has been lying on her side at Swanbister Beach. Cox & Danks, Ltd., the salvors, reports the *Engineer*, are floating the craft by filling her with compressed air, as was done in the case of some of the larger ships already brought to the surface by that company. At the time of writing, she was under several pounds air pressure and almost ready for turning bottomside up, in which position she is to be towed to the dock awaiting her. The work of getting the *Bremse* ready for removal will take about a month, owing to her awkward position. Other squads of men are busy preparing large air locks for the battleship *Prinz Regent Luitpold*, which is lying in deep water bottom upward.

There are nearly 100,000 miles of properly organized air routes in the world today.

Producing Granite Paving Blocks On a Large Scale

Means and Methods Employed at the Clark's Island Plant of John Meehan and Son

By THOMAS WENTWORTH

CONSIDER the granite paving block. It is not a thing of beauty, and its function is a passive one; but even so its utility is great although not unique. The modern paving block is the present-day substitute for the pioneer cobblestone and the more recent brick, and is superior in virtually all respects to its predecessors in the field of paving. Unpretentious though it may be, still the granite paving block has pronounced virtues of its own, and its employment is increasing rather than diminishing—road-builders and highway engineers recognizing its enduring qualities and peculiar fitness for certain exacting services.

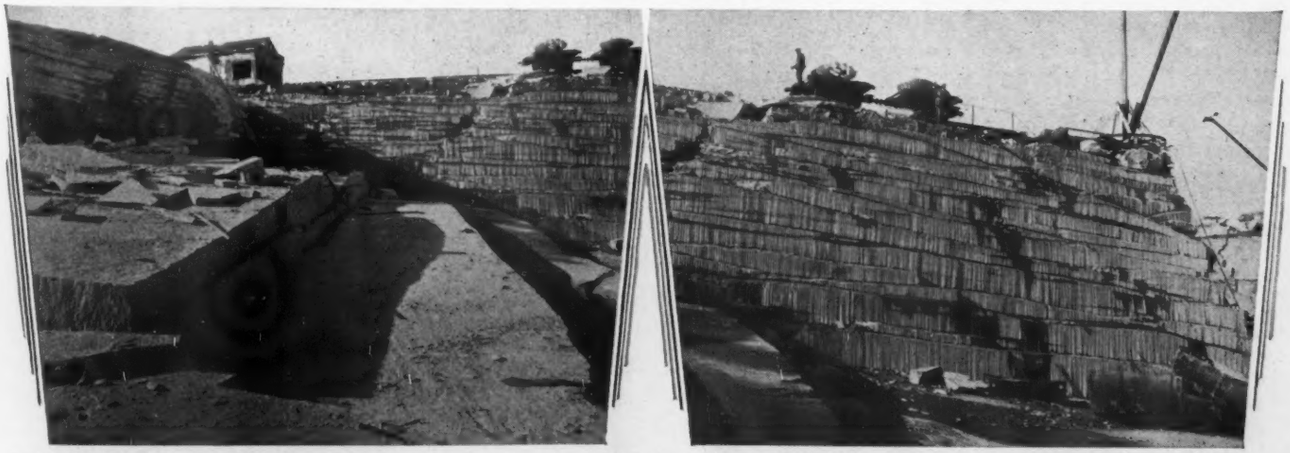
Channeling an end or wall cut with "Jackhamers". The near machine is drilling the holes and the farther one is cutting away the intervening bridges or cores.

Like so many other things that have become familiar, we accept the granite paving block as a matter of course, and probably but few of us have questioned whence they come and how they are made. Up to a point machinery does help to get the raw material out of the primordial ledge formed ages ago when the granitic substance, in a molten or plastic state, was forced surfaceward from the bowels of the earth; but, in the last analysis of the craft, the granite paving block is still in the main a handmade product and the consequence of a skill that calls for a considerable period of training.

We are informed that the City of Greater New York makes a more extensive use of granite paving blocks than any other municipality in the United States; and it is interesting to recall that the town's first use of flat stones for paving purposes was due to the enterprise and business shrewdness of one Polly Spratt—the descendant of early Dutch settlers—who, when she became the widow of Samuel Provoost, was obliged to manage the property then intrusted to her. Her estate lay on a side or unfrequented street; and to increase her revenue she built on the thoroughfare and in front of her home a line of shops. These might have remained untenanted for a goodly while but for a clever move on her part to attract trade. The street on which she lived was roughly paved with cobblestones, and often inches deep with water in the center—leaving only the sloping sides as a precarious footing for pedestrians. Hard as it must have gone against her thrifty habits, she leveled the ground in front of her shops and, from end to end of the block, laid thereon a sidewalk fashioned of sizable flat stones. That novelty drew the curious to that section of the town and multiplied her customers.

Subsequently bricks supplanted natural flat stones or flagstones in paving sidewalks. Eventually Belgian blocks, cubical blocks of granite, took the place of cobblestones; and because of their regularity of form they offered smoother and less noisy driveways for wheeled vehicles and the tread of shod draft animals. True, the Belgian blocks were noisy enough when iron- or steel-tired wheels rolled over them; but even so they represented a substantial improvement and they could be counted upon to withstand rough and heavy traffic for years before necessitating replacement. The granite paving block as it is now known to us is really an evolution of the Belgian block, which originated abroad.

There was a time in the history of granite blocks when they fell from favor as a paving material for the more pretentious thorough-



Left—Large slabs of granite are detached from the floor of the quarry by splitting them down to the natural sheeting planes along lines of plug holes drilled 6 inches apart and 3½ inches deep. The splitting is done with plugs and feathers and the holes are drilled with plug drills. Right—The side walls of the quarry are channeled with "Jackhamers" that drill holes half an inch apart—the bridges being removed with core cutters fitted to the same drills. The deepest cuts range from 6 to 7 feet.

Top—After the stones have been split to rough curbing dimensions they are placed on bankers in or in front of the cutting shed where the granite workers line the arrises with points and chisels. Bottom—When the arrises have been lined, the stones are swung by derrick around to surfacing machines by which they are pointed down to the lines and bushed with air-operated chisels.

fares frequented by carriages and other lighter vehicles. Then it was that such blocks were generally reserved for streets traversed for the most part by trucks and kindred heavily laden conveyances—that type of pavement not only being more rugged but offering a better foothold for horses when the streets were wet or covered with snow or a film of ice. In those days the blocks were set about an inch apart, and the intervening spaces or joints were filled with sand. It was inevitable that the sand would settle, the gaps become more pronounced, and the exposed edges of the stones be rounded or broken off—the whole surface growing rougher and noisier under traffic. Despite these drawbacks the pavement remained substantially sound and otherwise fit for service. It was this characteristic that arrested the attention of highway engineers in quest of roadway materials that would be able to stand up under the pounding impacts of heavily burdened and speeding motor trucks.

Within the last two decades, granite paving blocks have steadily won increasing recognition; and the demand for them has reached a point where we are utilizing annually in the neighborhood of 40,000,000 of them. These blocks are now so laid that they are pretty nearly as smooth as a brick pavement and far less noisy than the granite blocks that were set in sand and which were 7 or more inches in depth. The present blocks, as used in the truck-frequented streets of New York City, are from 6 to 10 inches in length, from 3½ to 4½ inches in width, and not more than 5¼ inches in depth. They are now often set upon a concrete foundation; and the joints between them do not exceed ⅜ inch in width. These joints are frequently filled with a bituminous binder—not sand alone, and, so laid, a pavement of this sort is easy to repair and superior to any other sort of wearing surface when exposed to severe stresses of heavy trucking. Needless to say, granite paving blocks are today required to meet rigid specifications that prescribe the physical characteristics of the granite that can be used as well as the dimensions and the finish of the blocks. So much for the evolution of granite paving blocks. Now let us see how they are made at the quarry and associate cutting yard of John Meehan & Son, Clark's Island, Me. This plant, near Rockland, Me., is said to be the largest enterprise of its kind in the country.

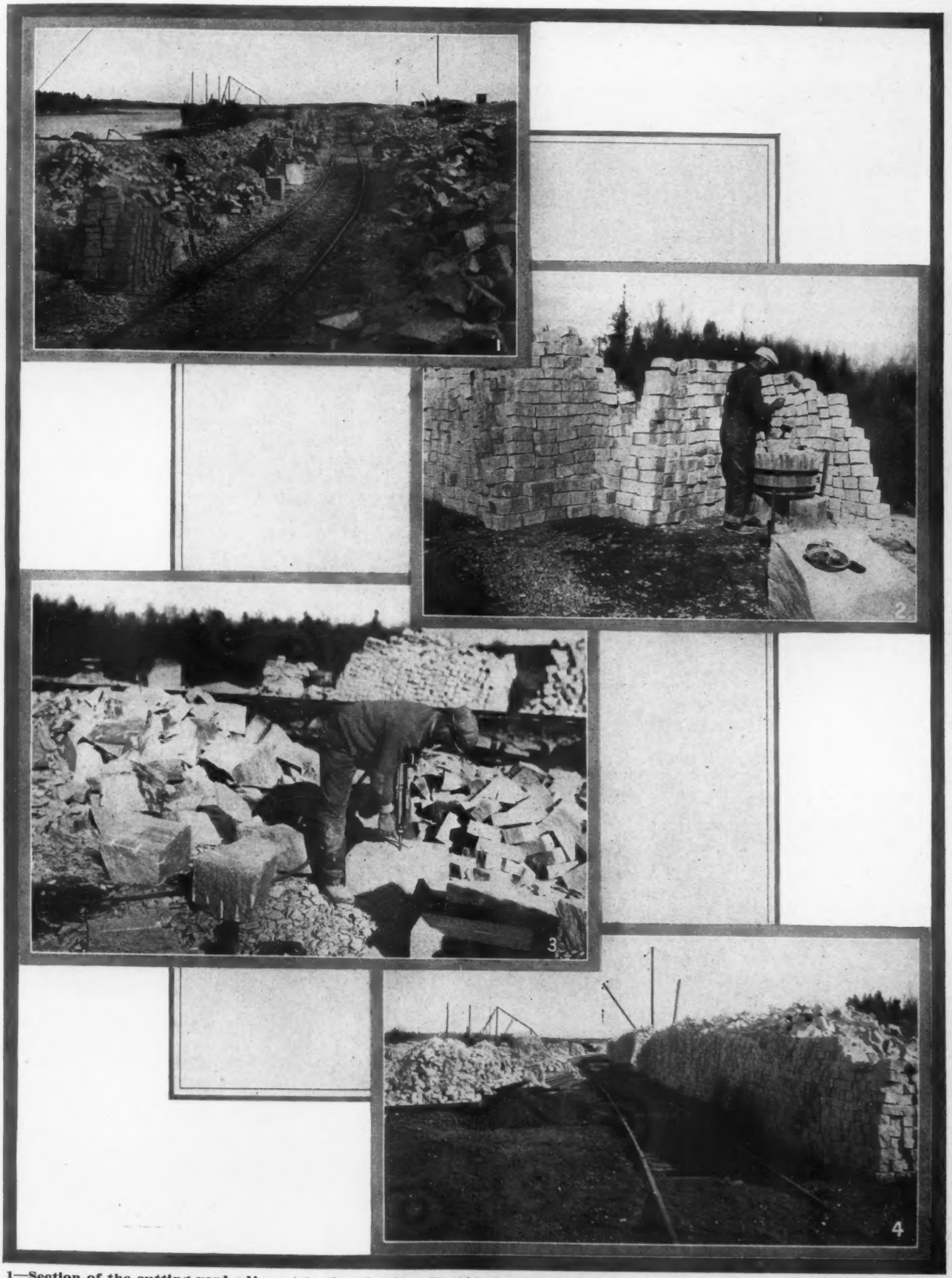
This picture of the first track to the wharf was taken during the winter of 1923.

The quarry was opened by the firm in 1921, and in a somewhat modest way. Expansion has been especially rapid in the last few years because of the high-grade product turned out and the resultant widespread recognition. Today, the quarry has an area approximately 500 feet square, and is down to a maximum depth of something more than 50 feet—with operations going steadily deeper in order to get out the quality of stone desired. The working force now numbers 300 men; and the annual output exceeds 4,000,000 paving blocks. These vary in size and relative dimensions according to the purposes to which they are to be put. Therefore, the blocks may range from 8 to 10 inches in length for some services and from 7 to 11 inches in length for others, while special blocks, cut to take the place of bricks, are considerably smaller.

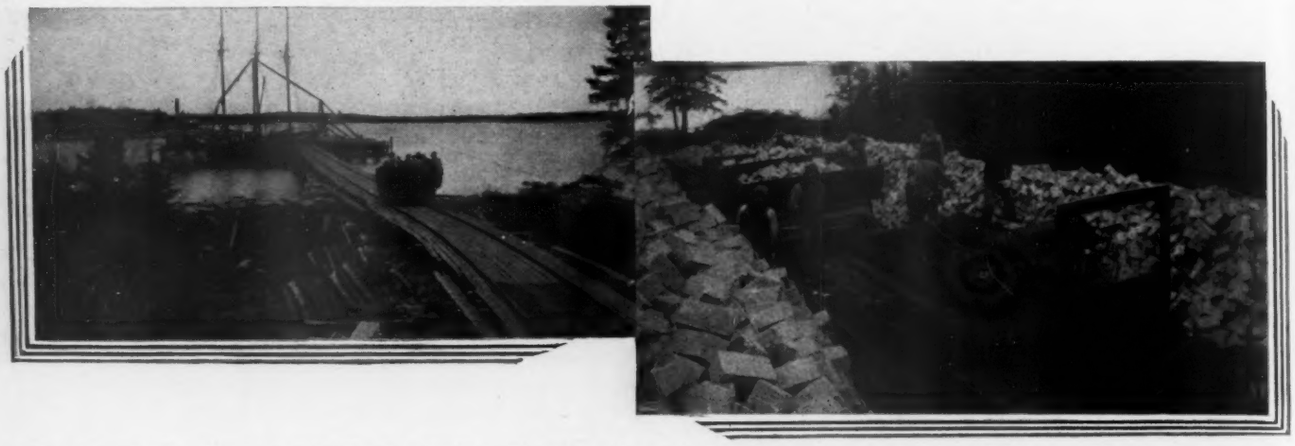
At Clark's Island the granite deposit has natural sheeting planes, and up to date the thickest layer or bed has not exceeded 7 feet. In getting this stone out in large slabs, that can be split successively into smaller and smaller slabs before being made directly into paving blocks, it is necessary to channel the side walls of the quarry and possibly one end of the slab to be removed. This relieves the rock of its initial stresses and facilitates the second stage of the work, which consists of drilling a line of holes parallel with the front of the lift or slab and from end to end of the piece. These plug holes are spaced about 6 inches apart and are 3½ inches deep. The actual splitting is done with a series of plugs and feathers progressively hammered deeper into the holes. A slab 181 feet in length has thus been detached at a single operation.

The channeling is done with Ingersoll-Rand "Jackhamers". These first drill a line of closely spaced holes and afterwards break down the intervening bridges of rock with core cutters substituted for the regular drill steels. The plug holes that are drilled parallel with the face or front edge of the slab are put down with air-driven plug drills. Once a slab or sheet is detached, in the manner described, it can be broken up into small slabs or blocks by drilling the necessary line of holes for the insertion of plugs and feathers. In the case of relatively small pieces, this work is usually done with plug drills; and Livingston plug drills are generally used by the quarrymen for this purpose.

Because of the nature of the rock obtained at Clark's Island and because of the skill exercised in getting it out of the ground and making it ready for the final cutting of paving blocks, there is a wastage of only one-



1—Section of the cutting yard adjacent to the wharf on Clark's Island. 2—The paving block is given its final form by skillful hammer blows imparted by an artisan. 3—Plug drilling a piece of granite preparatory to splitting it into slabs from which the ultimate paving blocks will be broken. 4—Many thousands of granite paving blocks stacked in readiness for shipping from Clark's Island.



Left—The wharf as it appeared when first built. Right—In the early days the carloads of paving blocks were hauled to the dock by a Ford truck.

third of the volume of rock quarried. The industry has been long established in Maine; and a cutter must serve an apprenticeship of two years and prove his fitness to be rated as a journeyman. The cutters work outdoors virtually the year round, notwithstanding the decidedly rigorous winters prevalent in that section of New England; and in the course of a day a proficient worker will produce 200 paving blocks.

The cutters receive pieces of granite large enough to make from 100 to 500 paving blocks; and they successively split the stone into smaller and smaller pieces until they have slabs equal to the thickness of two blocks. The splitting up to a point is done with wedges and shims driven into holes from 2 to 3 inches deep and spaced about 6 inches apart along traced lines. When the work has gone far enough to produce slabs as wide as a finished paving block is long and of a length equal to four blocks or more, the slabs are set on edge and a line traced through the center.

Next, a V-shaped groove 2 inches long and ¾ inch deep is cut with a bull-wedge chisel in the center of the line, and the block split by placing the bull wedge in the groove and striking it with a 24-pound bursting hammer. This obviates the need of plug holes. When one of these slabs is placed on a cutter's dressing tub, he traces a line across the center of the face, strikes the stone on the opposite side with a knapping hammer, and breaks the piece along the inscribed line. Once more the pieces are traced and finally broken into paving blocks. Any irregularities are dressed off by a cutter with a tiffler or reel.

To keep the drill steels and the cutters' hammers fit for their work, there is a corps of eleven blacksmiths. The drill steels are conditioned with a No. 33 Ingersoll-Rand sharpener, while the hammers are sharpened by hand—the cutters requiring sharp-edged hammers to give the blocks their specified finish. There are 170-odd block cutters in the open-air plant; and when at work at their chip-filled tubs they wear mittens made with two thumbs so that they can be turned and used twice as long in handling the keen-edged stone.

Lately, John Meehan & Son has engaged in the cutting of granite curbing; and the firm has made a radical departure in the art by adopting scientific methods and by utilizing pneumatic surfacing machines to expedite production and to insure uniformity in dimensions and finish. Stone for this purpose is delivered at the curb-cutting yard in large pieces, and there it is drilled and split to prescribed sizes. After the granite blocks have been split to rough curbing dimensions they are placed on bankers in front of the cutting shed by a centrally located derrick having a 65-foot boom. Next, the granite cutters line the arrises with points and chisels, and then the derrick swings the stones around to Livingston surfacing machines arranged on a semi-circular railroad track at intervals of 30 feet. The surfacing machines point the stones down to the lines and bush them with 4-cut chisels. These machines deliver short rapid blows that do the work without risk of breaking the stones; and one of them will cut the tops and faces as fast as two men can line the stones. Circles or corners are cut, with radiuses of 9, 12, and 18 feet, just as readily as straight curbing. The machines can cut a circular face; and it is necessary only to make two changes in bankering a stone to cut the entire face.

William T. Hocking, superintendent at the Clark's Island quarry.

The granite cutters and the machine operators do not banker their own stone. This is done by two men; and as soon as a stone is finished by a cutter he goes directly to another which is ready for him. While the surfacing-machine operator is cutting one stone another is being set up on the other side of his machine so that he has only to swing around to start anew when he has done his work on the first stone. All curbing cut at the Meehan plant is in accordance with Manhattan specifications, which require plumb sides and tops beveled or battered to conform to the slope of the sidewalk.

While horses first did the hauling, a number of steam locomotives now move the laden cars. Within the plant there are fully three miles of track; and compressed air is distributed to the quarry and to the cutting yards through piping having a total length of more than three miles. Operating air is provided by a battery of compressors having a combined output of 3,000 cubic feet of free air per minute. In cold weather all air lines are blown out at night; and moisture traps are installed at every low point. Water is obtained from three Artesian wells; and 30,000 gallons are pumped per diem. The water is stored in an underground tank to keep it from freezing in the wintertime.

Under normal conditions, the facilities at the dock are called upon to load about 400 tons of paving blocks daily; and the fact that the plant can ship at tidewater makes it possible to reach other seaboard points quickly and at a comparatively low transportation cost.

Mexico has approximately 5,700,000 acres under irrigation, leading all Latin-American countries in this respect.

Maracaibo, Venezuela, in a span of a few years, has become the oil metropolis of South America and the world's second largest oil producer.

Greater Detroit Has an Interesting Semi-Suburban Ice Plant

Ferndale Plant of Detroit City Service Company Has Shown How Substantial Savings Can Be Effected

By A. S. TAYLOR

DETROIT can boast of something more than being the automobile-manufacturing center of the world—it is a large and beautiful city favorably located on a number of waterways, and it is making a continually increasing appeal to the home lover. These facts explain in a measure why the population of Greater Detroit now numbers more than a million and a half. As might be expected in a community seeking ceaselessly to merit metropolitan repute, the people of this enterprising and attractive Michigan city are equally insistent that they shall have all the comforts in abundance that go to make up the sum of present-day living standards. The purpose of the Detroit City Service Company is to contribute to this demand in its chosen field of activity. This article describes one phase of this service.

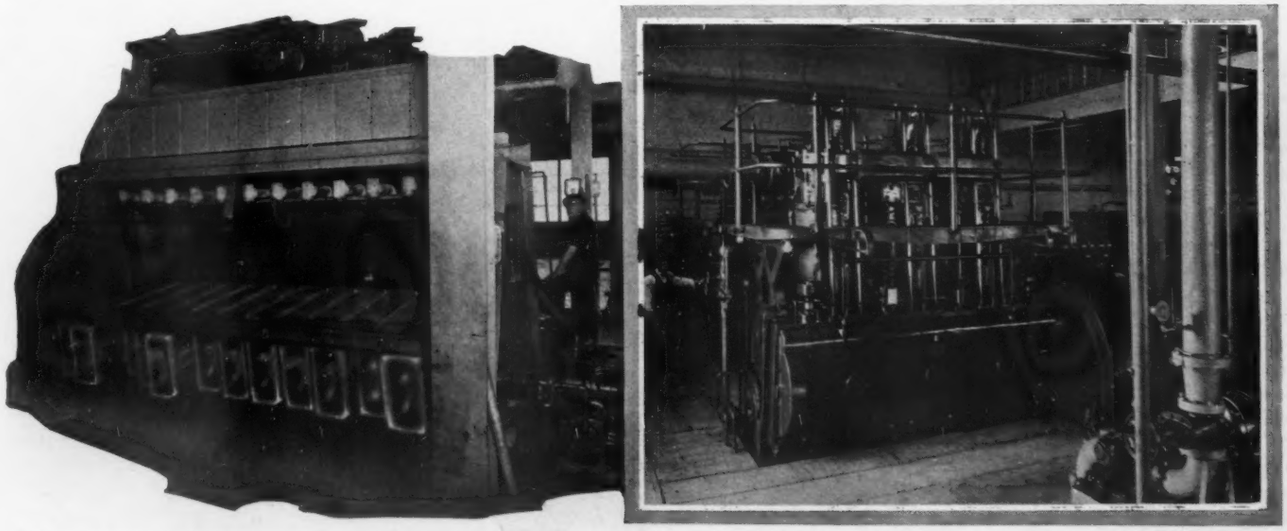
Domestic refrigeration used to be an intermittent requirement—the need being light during the cold months and decidedly heavy throughout the really warm months of the summertime—spring and fall being the periods of transition. Today, no matter what the temperature, ice is purchased in large quantities—the maximum market coming, of course, at the season when the sun beams not infrequently with intemperate vigor. One function of the Detroit City Service Company is to provide aplenty of ice the year round—varying its production as circumstances dictate. To meet these changing conditions and to satisfy all its customers throughout the widespread area of Greater Detroit, the company has called into being a number of ice-making plants and has located them at strategic points where they can reach their respective patrons with the least delay. All told, the company operates within the limits of the greater city as many as 23 stations. Twelve of these are ice-manufacturing plants, and the others are ice-storage plants each of which has a capacity of something like 10,000 tons. This article has to do with the ice-making plant that is situated in Ferndale.

Ferndale is a suburban section of Detroit that lies to the north of the civic center. The Ferndale ice plant—officially known as Plant No. 20—provides ice for 30,000 people living within a contiguous area of six square miles. To be exact, it supplies, besides Ferndale, the communities of Royal Oak, Birmingham, Berkley, and Hazel Park. To do this at the season of peak demand the station must have an output of 160 tons of ice every 24 hours. Like other ice plants owned and operated by the Detroit City Service Company, the Ferndale station has been designed with an eye to the future—that is to say, to grow up with the dependent section and to be operable as economically as possible during the years of expansion. Only with this thought continually in mind would it be practicable to establish plants of this description for the convenience of the neighboring people and to run them at a profit while selling their single product at a reasonable price.

Ice is made by expending power, and whatever may be the source of that power it is essential that the cost of it be kept as low as possible. This is especially true of a plant having a widely variable load and which must be over-equipped in capacity at the start. Therefore, the Detroit City Service Company, after ripe experience, determined to make the Ferndale plant a more or less experimental station in the matter of its source of primary power. After a careful canvass of the field, the company elected to try heavy-oil engines as prime movers—in this respect making a distinct departure from its previous practice. Its engineers figured that they could thus meet local conditions satisfactorily and at the same time effect a worth-while saving. We shall see presently how far their expectations have been fulfilled.

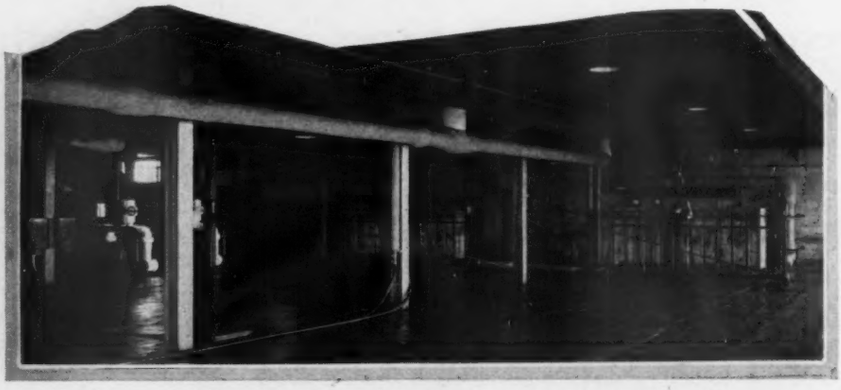
The Ferndale plant is equipped with two 330-hp., Type PR, solid-injection Ingersoll-Rand oil engines, each having three cylinders. These engines make 225 revolutions a minute, and each drives a 220-kw. General Electric alternating-current generator. Both engines are operated when the plant is producing ice at its maximum capacity. The current derived from the generators is used to drive two ammonia compressors, to operate pumps, agitators, hoists, and a compressor furnishing starting air, and to run various other auxiliaries about the station. The plant began to make ice in July of 1928, and it has been operating continuously since then.

The ice is made from raw water obtained from the Detroit city mains; but before the water is run into the cans it is treated to soften



Left—Dumping machine in the Ferndale plant. Twelve cans are handled at a time. Right—The two 330-hp., Type PR Ingersoll-Rand oil engines. Each engine drives a 220-kw. generator.

it to the desired degree, in which state it has 2.8 grains of hardness. The water in the cans is agitated with air at a pressure of 12 pounds per square inch. The ice tank is capable of holding 1,824 cans; and each cake of ice weighs on an average 330 pounds, but it is sold as 300 pounds. When visited during May just gone, 960 blocks of ice were being pulled every 24 hours. The refrigerating capacities of the two ammonia compressors are, respectively, 55 tons and 265 tons.



Tank room of the Ferndale plant of the Detroit City Service Company. The tank has a capacity of 1,824 cans, each of which produces a cake of ice weighing on an average 330 pounds.

The ice tank is divided longitudinally into virtually two separate compartments; and the brine is circulated through these subdivisions by four electrically driven agitators —one at each end of each compartment. It takes 47 hours to freeze the water in a can. The practice is to pull twelve cans at a time, and this is done in the manner shown by one of our illustrations—a hoist being utilized to do this work from a traveling crane that is electrically operated. The crane and the hoist carry the cans to the dipping tank where they are submerged in warm water drawn from the circulating system of the oil engines. This re-use of the water so heated represents an operating saving. From the dipping tank, the cans are raised by the hoist and moved by the crane to the dump, where the blocks are discharged and conveyed into the ice-storage room.

The two oil engines have now been in active service over a period of twelve months; and during much of this time both engines have been run simultaneously. According to Mr. D. R. Clodfetter, chief engineer of the plant, the engines have performed satisfactorily the whole while and have developed no troubles of any sort. At three-quarters of full load, which is a common operating condition, the plant utilizes 7,000 kw. of current in the course of each 24 hours. For lubricating and fuel oils, this current costs from five to six mills per kilowatt.

The starting air for the oil engines is supplied by a 4½x5-inch, Type 15, motor-driven, I-R vertical compressor; and the air is stored in three receivers that are hooked up in series. The lubricating oil is cleaned by a De Laval purifier that contributes to the operating economy of the plant. The working force of the establishment is made up of six men, three engineers and three tankmen. The tankmen work ten hours to a shift and the engineers nine hours to a shift.

The Ferndale plant has so far been able to take care of the demands of the region served without any amplification of equipment; and the station has also furnished much valuable data that will be of assistance to the company when the time comes either to enlarge Plant No. 20 or to equip other plants that may be called into being for the convenience of other growing sections that would naturally look to the Detroit City Service Company for ice.

The Ferndale plant of the Detroit City Service Company that supplies 30,000 people with an abundance of ice the year round.

CHANNEL TUNNEL PROJECT AGAIN REVIVED

IT IS reported from abroad that the Channel Tunnel Committee, appointed by the British Government last spring, has reported favorably on the proposed railway tunnel between England and France, which has been under advisement frequently during the past 50 years. The committee scoffs at the idea of an invasion by way of such a tunnel—heretofore the main talking point of the opposition, and recommends that the government proceed with its construction. Work would thus be provided for 12,000 men for a period of four years. The present plan, which involves an estimated expenditure of $150,000,000, includes the building of two sumps—one on each side of the Channel—so that either nation could promptly flood the tunnel should such be advisable in case of war.

CONFIRMATION

WE believe the following letter from Mr. Edwy E. Benedict, of Waterbury, Conn., will be of suggestive value to our readers:

"I was quite interested in the article, *Sugar Offsets Fatigue*, in your September issue, as it brought to mind the experience of my hunting days. I always took with me a half pound or so of cube or cut sugar, and a very light lunch if I was to be gone all day.

"For a man used to city streets and office work, tramping through the woods and over hills is somewhat strenuous, and that tired feeling is sure to come. But when it did, I found a convenient place to sit and absorb two or three cubes of the sugar, and in ten minutes or sooner I was as fresh as ever and ready for a few more miles of tramp—finally swinging around to the house with only a pleasant tired feeling.

"If any of your force have the hunting or tramping habit, would advise the sugar treatment."

SOLARIUM FOR THE BENEFIT OF MINE WORKERS

THE Bunker Hill & Sullivan Mining & Concentrating Company has embarked on a program of welfare work that would seem to be a step in the right direction. At its Bunker Hill plant, in Idaho, that company is now building a solarium where its underground toilers may enjoy the health-giving benefits of the ultra-violet ray denied them so much of the time because of the character of their work.

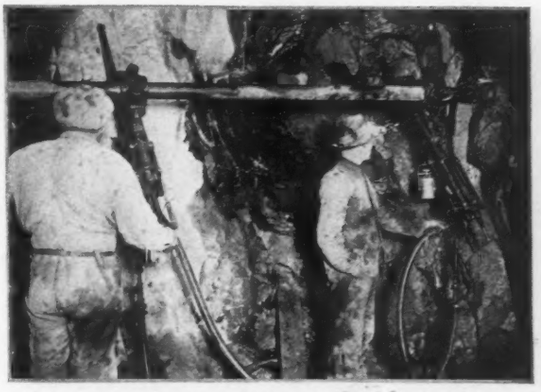
The solarium is being made a part of the company's dry room, and will be capable of treating 150 persons in an hour. This is achieved through the agency of a moving platform, which will carry the men slowly through a narrow cabinet equipped with six powerful mercury-quartz lamps—the arrangement being such that the artificial sunlight will strike every part of the body. The solarium will be available to the miners' families; and, if the results obtained are such as to justify the outlay—$10,000, the company's other properties will be similarly outfitted.

A bridge across the Panama Canal is urged to serve as a link in a proposed highway extending from Mexico into Colombia.

Long Tunnel Recently Completed for Norwegian Power Company

By J. S. MEEHAN

NORWAY can boast an abundance of snow and ice and rain. Such a meteorological condition may seem undesirable to people dwelling where the sun normally shines much oftener and dark and wet days are in the minority. Even so, Norway is blessed because of her heavy precipitation, for it keeps her rivers filled and flowing swiftly toward the sea the year round. These rivers are a form of natural wealth that is being turned more and more to profitable account.



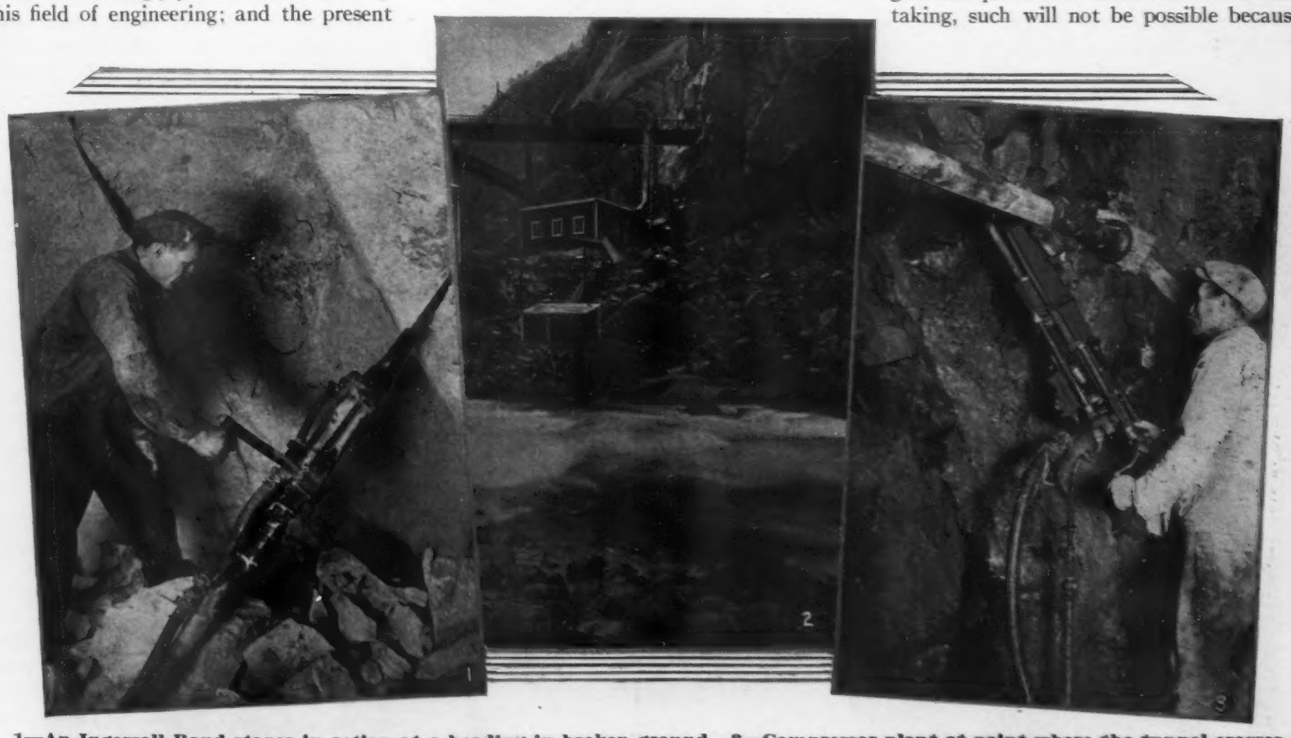
Two Ingersoll-Rand N-72 drifters mounted on a 3½-inch shaft bar at one of the tunnel headings.

In most instances, Norway's watercourses are relatively short; and in their efforts to reach the ocean they drop at times abruptly from altitudes that provide splendid heads for the driving of turbines in hydro-electric stations suitably located to make the most of the propulsive energy in those streams. Norway has already utilized some of her rivers for the generating of large blocks of electric power that are employed industrially and for numerous other services; and it is inevitable that the country will use her falling waters in the future to produce increasing measures of electric current. The more she does this the richer she will be in material comforts, conveniences, and fields of gainful employment.

During the past two decades, development has been outstandingly pronounced in Norway in this field of engineering; and the present article has to do with one of the latest undertakings of this sort—a project calling for the erection of an impounding dam, for the driving of a long tunnel through rock, and for the construction of a power station that will have an eventual water-wheel installation capable of generating a total of 90,000 hp. The work is being done by the Sauda Falls Power Company, Ltd., and the energy is to be used for producing carbide and ferro-alloys by the Electric Furnace Products Company, Ltd., a sister company of the power company in question and a subsidiary of the internationally known Union Carbide & Carbon Corporation.

The Storelven River drains a considerable area in southwestern Norway—the waters flowing into the stream from a series of lakes fed largely by the melting of snow and ice lying in the deep valleys and on the upper slopes of the enveloping mountain region. This, in conjunction with a heavy rainfall, insures an abundant and at times a riotous flow of water. The Sauda Falls Power Company, Ltd.—otherwise known as the Aktieselskabet Saudefaldene, has already made good use of this drainage area; and the work it now has in hand will make still more effective the energy that can be drawn from the Storelven. The river empties into the headwaters of the Saudafjord at a point about 56 miles to the northeast of the well-known city of Stavanger, situated on the North Sea coast of southwestern Norway. The new station will be known as Power Plant No. 3; and will be downstream from those already built. It will be a fine example of skillful engineering, whereby the waters of the river will be used for a third time in generating a large block of electric current.

Interesting as it would undoubtedly be to give full particulars about the whole undertaking, such will not be possible because of



1—An Ingersoll-Rand stoper in action at a heading in broken ground. 2—Compressor plant at point where the tunnel crosses the valley of the Storelven River. 3—Close-up of an N-72 drifter at a heading in hard granite.

Looking toward Juvastol from a point above the site of the dam for Power Station No. 3. An impressively picturesque section of the Storelven Valley.

the limited space at present available. We shall, therefore, confine our story in the main to describing how the tunnel has been driven that will link the water in the impounded area with the turbines to be placed in the generating station at the head of Saudafjord. This tunnel has a total length of 23,665 feet—that is, 4½ miles—between the easternmost portal or intake at Storlivann and the discharge end of the tunnel just above the power plant. In its journey from the artificially formed regulating basin to the intakes of the turbines the motive water will have a head or drop of 760 feet.

Strictly speaking, the tunnel is in fact two tunnels that are united by a steel pipe, 10½ feet in diameter, carried across the river valley by an arched, iron bridge. The easternmost section of the tunnel taps the storage basin through the dam, that will stand squarely athwart the Storelven River, and extends thence to the south and west for 4,133 feet—coming out on the northern side of the river valley. The much longer second section of the tunnel begins on the opposite side of the stream and continues on a changing line for a distance of 19,532 feet until it is joined by the steel penstocks that convey the water directly to the turbines. The tunnel has been driven from eight points of attack, that is, from the four portals of the two sections and from four suitably situated adits—the longest of which was advanced 492 feet in order to intercept the line of the tunnel. This was Adit No. 3. The portals and the adits made it possible to carry on the work simultaneously at twelve headings; and this arrangement, in combination with efficient equipment, has contributed much to the excellent rate of progress made.

Driving of the adits was begun in June, 1927; and work at the main-tunnel headings was started as soon as the tunnel line was reached. This was accomplished before the end of 1927; and by the close of that year an aggregate of 1,689 linear feet of main tunnel had been drilled and blasted. In 1928 a matter of 15,170 linear feet of advance was made in the main tunnel—continuous operations being carried on only at eight of the headings. The average progress during that twelvemonth was at the rate of 1,804 feet per heading; and the greatest progress made in the course of a month at one heading was 198.44 feet.

Tunnel work during the current year was confined principally to driving the heading down from Adit No. 2 and the heading upward from Adit No. 3. Between the first of January and the end of August a total footage of 6,041.75 feet was made—leaving only 764.25 feet to be driven in the remaining months in order to complete this part of the momentous undertaking. This has been accomplished; and, as a consequence, the tunnel has been finished fully five months in advance of the estimated schedule. The record execution of the task by the two contractors on the job was due to two outstanding factors. Because of the considerable number of tunnels built for the country's railways and kindred work done in constructing the many power plants

that have come into being in Norway in the past twenty years, there was available a large body of capable workmen well trained in tunnel driving. Besides utilizing this experienced personnel, the contractors wisely equipped themselves with the best tools and machinery they could obtain for pushing forward the project.

It is interesting to recall that previously the majority of the drill runners had generally used stopers for such work. Accordingly, stopers had the preference at the start of operations, although some drifters were provided. Drifters were at the time a type of rock drill with which most of the men were unfamiliar; and gradually stopers supplanted the drifters until but one of these remained on the job. The runner of that single machine held steadfastly on to it; and his superior performances with that tool attracted the attention of his fellow workers and the bosses. The greater effectiveness of the drifter became apparent to all concerned, especially when penetrating the hard granite through which the tunnel has been driven for nearly its whole length—soft rock occurring only for short distances and in a few places. The tide eventually turned in favor of drifters as the workers learned to handle them and to appreciate how much more they could do in the course of a shift. In the end, drifters were relied upon to do most of the drilling; and how well they played their part in the undertaking is evidenced by the speed with which the tunnel has been carried to its conclusion.

Owing to the low temperatures prevailing in Norway during the winter season, the contractors used for blasting a low-freezing dynamite of comparatively recent development. This dynamite, manufactured for the purpose by the Norwegian Dynamite Company, contains glycol dinitrate, which is made from ethylene glycol produced by the Carbide & Carbon Chemicals Corporation, a subsidiary of the Union Carbide & Carbon Corporation.

The use of pure glycerine dynamites in winter or in decidedly cold climates is attended with great danger arising from the freezing of the active nitroglycerine and the subsequent necessary thawing of the explosive to make it serviceable. The substitution of ethylene glycol for some of the glycerine during manufacture forms an explosive which has a notably low freezing point and which, in addition, possesses other advantages with no attendant reduction of propulsive strength. In the few years that ethylene glycol has been commercially available, it has brought about a great improvement in the quality of explosives as well as in their safety; and this ingredient is now employed by the dynamite industry in all parts of the world. For various reasons, but mainly because of the character of the rock encountered at different points, the consumption of explosives per meter (3.28 feet) of finished tunnel has varied considerably, and has ranged from 35.25 to 83.75 pounds.

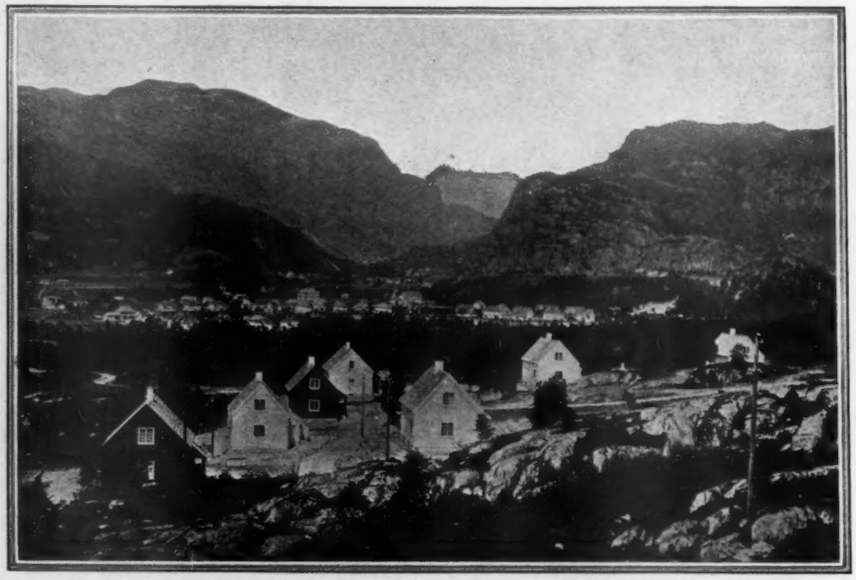
For the work, each contractor used two regular shifts composed of from five to seven men at each heading, and a night shift made

1—One of the numerous lakes in the watershed tributary to the Storelven River.

2 and 3—Views of one of the power dams on the Storelven.

4—A typical section of the rock-ribbed region forming the watershed of the Storelven River.

up of two to three men. In addition, a man was detailed to each compressor; there was a driver for the locomotive employed in mucking; a blacksmith for each shift; and a gang that did the tipping of the muck cars. The drifters were Ingersoll-Rand N-72's, carried on 3½-inch bars. These drills were supplied with 1¼-inch round steels: the stopers with 1-inch hexagonal steels—all being made of Sandviken steel. The rock drills were equipped with Ingersoll-Rand air-line lubricators.



Sauda Falls Power Company settlement above Sondenaahavn, Norway. This is typical of the manner in which the permanent personnel is housed at its great hydro-electric stations.

At some of the adits difficulty was at first experienced in procuring the necessary supply of water for the drills, but this was overcome by placing in each of them a pressure tank which was successively set in pits excavated for that purpose at convenient points in the floor of the tunnel. The accumulating water was admitted from the pit to the tank by way of a cock fitted at the lower end of the container. When the tank was full, the cock was closed and air pressure applied to the free surface of the contained water. In this way the necessary "head" was given the water to feed it to the drills. Each tank had a capacity of about 106 cubic feet; and as a heading advanced the associate tank was moved forward to a new pit—thus obviating the employment of long lengths of piping.

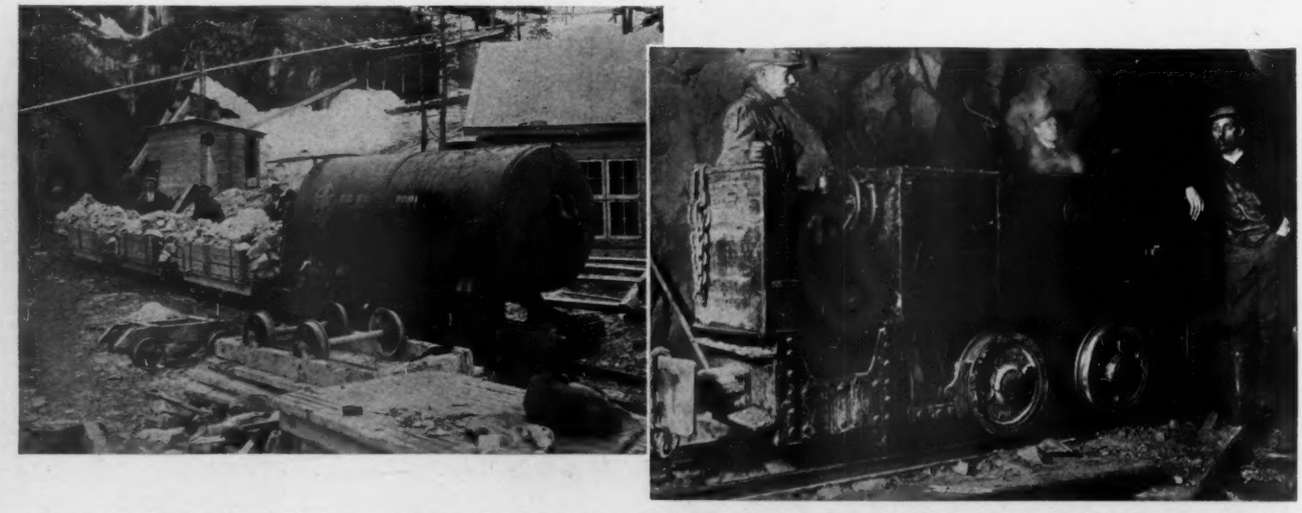
Galvanized piping, with insulating covers, was used for both compressed air and water mains within the tunnel. Outside, however, where the lines were exposed to much lower temperatures, they were wrapped with electric heating cables. This arrangement effectually safeguarded the conduits from freezing—frost interfering with the work only on a few occasions.

Operating air was provided by five Ingersoll-Rand compressors, and one was placed at each working base. The four stations at adits Nos. 2, 3, and 4, and where the river valley is crossed, were equipped with XRB-2 compressors each delivering approximately 900 cubic feet of free air per minute. At Adit No. 1 there was installed a Type ER-1 machine with an output of about 353 cubic feet of free air per minute. Compressed air was distributed to the headings through 4-inch piping. The blacksmith shops were equipped with air-operated drill-steel sharpeners.

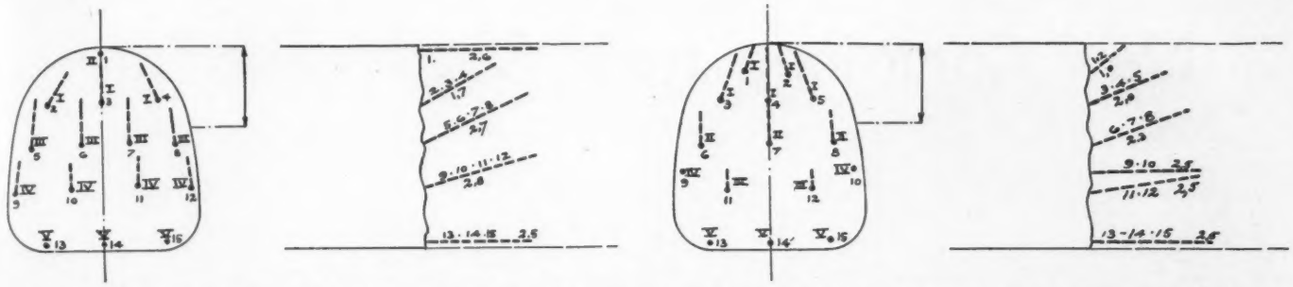
At adits Nos. 3 and 4 two Sirocco fans were installed in the main tunnel having each a capacity of about 3,390 cubic feet per minute. The fans drew the smoke and gases from the headings through a 12-inch pipe and then impelled them outward through the adits. At the other adits high-pressure exhausters were provided, and each of these had a capacity of 7,060 cubic feet of free air per minute. Where these were used the air was forced into the tunnel through 20-inch piping. Both systems cleared the air sufficiently after each blast to permit resumption of work at the conclusion of an hour or an hour and a half; but the arrangement with the Sirocco fans proved more economical in the consumption of power and somewhat superior in its air-conditioning work.

Transportation at the lower adits was effected by means of aerial ropeways; but at the valley crossing and at Adit No. 1 haulage was made comparatively easy by the availability of roads at suitable levels. The muck cars were moved by locomotives. At the valley crossing and at Adit No. 2, a 15-hp. benzol mining locomotive of the Deutz type was used; and at adits Nos. 3 and 4, a low-pressure air locomotive of the Atlas type was employed. At each adit the locomotive in service moved between 70 and 80 carloads of rock in the course of 24 hours.

The camp provided at each working base had accommodations for 34 men, as well as proper housing for the compressors, blacksmith shop, and transformers. Electric current for driving machinery and for heating purposes was taken from the existing high-tension transmission line leading to the plant of the Electric Furnace Products Company, Ltd., and was carried by a reinforced aluminum cable to the different adits where it was stepped down to a suitable voltage. The power consumption at each working place averaged



Left—Type of compressed-air locomotive used in hauling muck trains at adits Nos. 3 and 4. Right—At Adit No. 2, where the tunnel crosses the river valley, the muck trains were hauled by this type of benzol mining locomotive.



Left—Regular top-cut round used in penetrating broken ground. Right—Regular top-cut round used in penetrating hard rock. The roman numerals indicate sequence of firing.

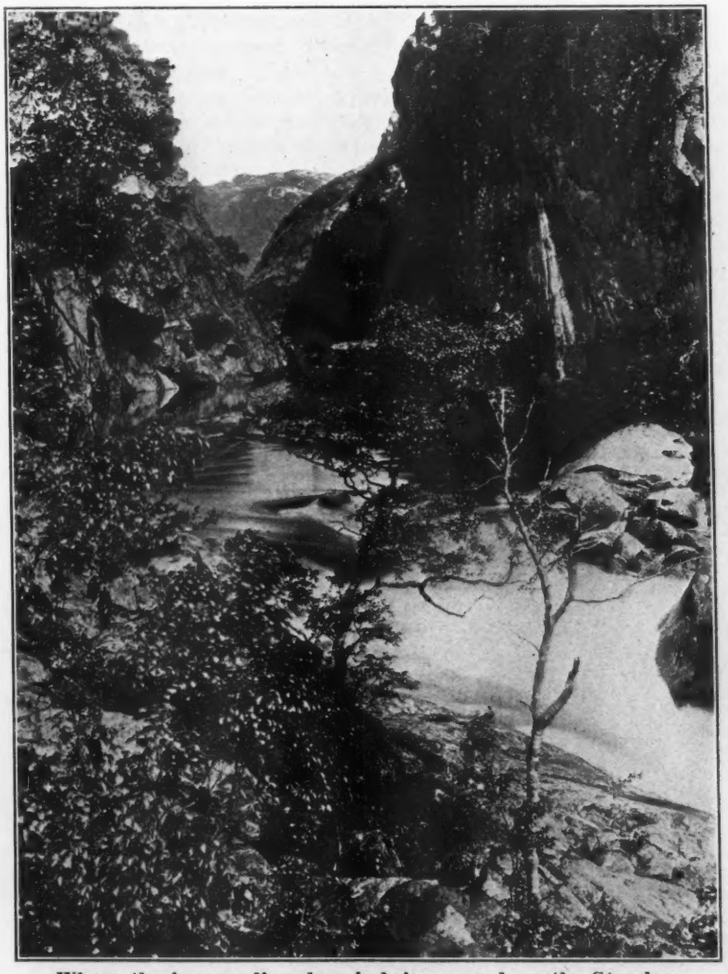
about 200 kw.

As has already been mentioned, the completion of the undertaking reflects great credit upon all concerned, and it exemplifies what can be accomplished when capable operatives and the best of obtainable equipment are employed.

The present hydro-electric undertaking focuses attention once more upon what Norway is doing to capitalize her water-power resources which, for a long time, were valued principally because of their arresting picturesque appeal. In the course of the years that have passed since the nation's engineers first installed modern water wheels and began to generate considerable blocks of electric energy, progress in this field has gathered impetus steadily and, as a consequence, there have come into being various industries that can develop and flourish best only when operating current can be had in generous measure and at moderate cost. This is especially true of certain electro-chemical departments of industry. In some of these Norway has been a notable pioneer; and the rest of the world has profited by that Scandinavian enterprise.

An interesting feature of the annual convention of the National Industrial Advertisers' Association, held not long ago in Cincinnati, Ohio, was an exhibition of a wide-variety of ads that attracted much attention. Among those to get awards was the Oxweld Acetylene Company, which received first prize for the best individual trade-paper advertisement and second prize for the best series of not less than six advertisements depicting performance. Jenkins Brothers, manufacturers of valves, carried off a silver cup for their contribution to the art of industrial advertising.

A signal giving warning to a press operator when the air pressure of a pneumatic cushioning system has reached its minimum is being used with good effect to prevent damaging dies. The indicator consists of an electric circuit closer attached to the moving part of the pressure regulator in such a manner that a red lamp is lighted directly in front of the operator when the pressure drops to the lowest limit. If it is desired to provide a switch for breaking the circuit, it should be of the knife type and so placed that the handle will interfere with the tripping of the press when the switch is open.



Where the impounding dam is being reared on the Storelven River to turn the waters of that stream into the long tunnel leading to Power Station No. 3.

MINING INDUSTRY FINDS NEW RUBBER USEFUL

CHEMICAL research has produced a new kind of rubber, called "Linatex", which is said to possess properties superior to those of the familiar commodity fashioned of crude rubber. The new material is made direct from the latex, permitting a more thorough admixture with the compounding ingredients; and it is generally about 95 per cent rubber, a high percentage. It can be turned out only in sheet form; but the sheets, through the use of a special solution, can be built up into a variety of shapes.

Writing on the subject in the *South African Mining and Engineering Journal*, a correspondent says: The Malay tin mines were among the first to apply "Linatex", and they used it instead of white iron and manganese for lining launders and chutes leading from the tin dredges. Although much lighter in weight than the metal lining, which had to be removed every four or five months, "Linatex" has shown no signs of wear after eighteen months of service. Shoes of gravel pumps, throats of hydraulic elevators, and bores of pipes conveying abrasive mixtures of solids and water have been similarly protected with outstanding results. There are many directions in which the new rubber compound can be employed to advantage in the mining industry. As tube mill liners, for example, it is standing up well.

Metal cans and glass containers for preserved foodstuffs may be doomed if the claims for a newly found cellulose product be correct. The material was discovered accidentally in the laboratories of the Eastman Kodak Company. It is said to have the strength of metal, the transparency of glass, and to be suitable for manufacture into cans and bottles.

New Containers from Old Newsprint

A Recent Development in the Utilization of a Waste Product That Has Great Possibilities

By S. G. ROBERTS

YOUNGSTERS in Anacostia—a semi-suburban section of the City of Washington, D. C., are happy because they know just how they can add to their resources when they need money for the movies, change for a circus ticket, or funds for a multiplicity of other pleasurable purposes. To swell their purses, the lads of Anacostia have only to collect and to bundle old newspapers to earn 30 cents a hundred pounds for that scrap material. This situation represents another milestone in the march of modern industrial progress, because it reveals how a material that generally goes to the city dump or is burned up to get rid of it can now be worked into a variety of useful forms.

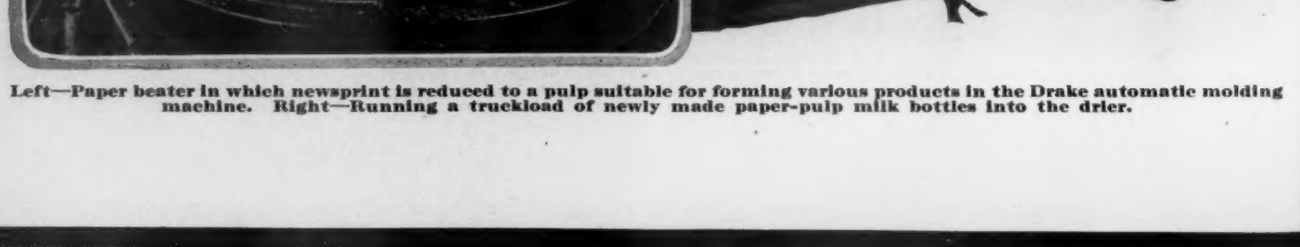
At its plant in Anacostia, the Pulp Products Corporation produces seamless containers of divers sorts; and old newsprint is one of the basic substances used in doing so. At the present time, substantially a ton of this stuff is utilized daily, and it is made over into circular cigar boxes, berry boxes, flower pots, propagating pots, and commercial containers for a number of commodities such as hardware, piston rings, etc. In the manufacture of these the company employs what is known as the Drake process. This process is an ingenious adaptation of certain procedures extensively used in the paper-making industry, but so modified that the ultimate product differs widely from the familiar papers fashioned primarily from wood pulp.

Anyone at all acquainted with the manufacture of newsprint will recognize at once that the Pulp Products Corporation leaves to the regular paper mill the work of chipping or grinding pulpwood logs and of afterwards transforming them by various operations into the "stock" that is floated on to the screens of the paper-making machines—thus avoiding the expenditure of much time and money, the need of considerable skilled labor, and the employment of different kinds of costly machinery. These facts are mentioned merely to emphasize some of the economic aspects of this new departure in industry. All the plant in Anacostia has to do is to again reduce clean waste paper to a fluid, pulpy state to facilitate handling by the apparatus that quickly reforms the stuff into the articles already named. Before describing the steps by which this is accomplished, it might be well to explain why the company has elected at the start of its activities to turn out those particular commodities.

The District of Columbia lies adjacent to states in which much tobacco is grown and made into cigars. In the same region a great many thousands of boxes of luscious berries are raised annually—not to mention other small fruits; and flowers and vegetables are produced on an extremely large scale not only for what might be called local consumption but for profitable markets in other states. These circumstances explain why there is a continually increasing demand for circular cigar boxes, for flower and propagating pots, and for berry boxes that can be utilized in getting certain of the fruits from the grower to the consumer. The average person has no conception of the tremendous number of berry boxes required every year—the great majority of which are fashioned directly from lumber prepared for the purpose. We need not stress the fact that timber is becoming more and more expensive; and there is, therefore, warrant for substituting something that will serve the same end and cost much less. The berry boxes made by the Pulp Products Corporation satisfy these requirements; and, physically, they are the equal in every way of the wooden ones.

The pulp pots for propagating differ in two respects from those intended for flowers: they are square instead of round, and their walls are much thinner because they are designed to be used only during the growing of seedlings or cuttings for transplanting. The flower pots are usually colored red to simulate the appearance of those fashioned of clay; and they are sufficiently durable for general purposes—they will not break when dropped or struck as would clay ones.

Of the several commodities manufactured by the Pulp Products Corporation at Anacostia, none is more interesting or more significant than the paper-pulp milk bottles. These and other containers for foodstuffs are made from blank news scrap, unprinted. We are all familiar with the glass milk bottle, and we have been made acquainted with its so-called shortcomings. The glass container must be used a number of times to offset its original cost; and each re-use necessitates handling and washing under conditions that should sterilize it before refilling—otherwise it becomes an insanitary vehicle for the distribution of milk. There is a large loss to the dairyman due to breakage; and the glass milk bottle must be heavy in order to give



Left—Paper beater in which newsprint is reduced to a pulp suitable for forming various products in the Drake automatic molding machine. Right—Running a truckload of newly made paper-pulp milk bottles into the drier.

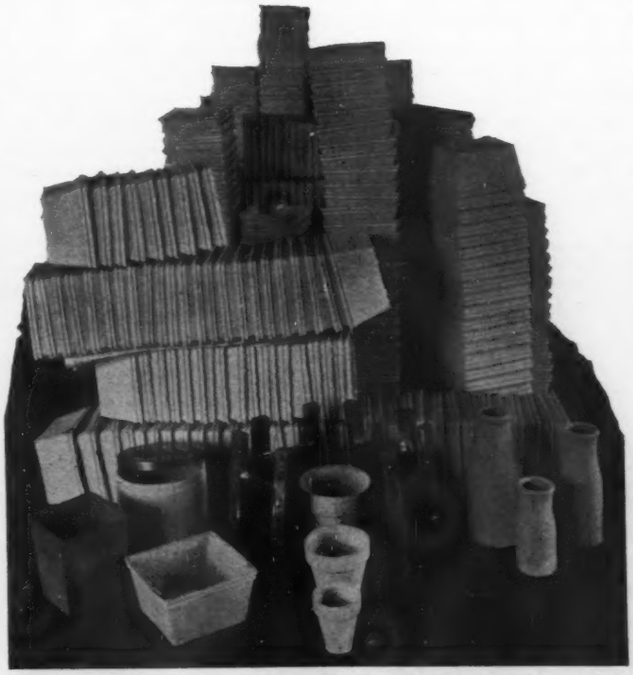
Left—Drake process automatic molding machine capable of turning out ten paper-pulp products at one time. Right—Superheater used in connection with the Drake machine.

it the desired degree of strength to permit more or less rough treatment. Its average life is between seven and eight trips in the cities of the United States; and a quart container weighs 1¾ pounds.

The paper-pulp milk bottle is intended to be filled but once and thrown away after it has been emptied. It is seamless and strong enough to meet all service requirements—its crushing strength, when compressed vertically, being 100 pounds. The paper-pulp quart bottle made by the Drake process weighs 1¾ ounces, as against 28 ounces in the case of the glass bottle of equivalent capacity, and because of its low price and lightness will save the dairyman, so it is computed, about 25 per cent of the total cost of handling milk bottles—excepting that of delivery. Furthermore, the paper-pulp bottle will keep its contents unimpaired over a considerable period of time. Apart from being sterilized when made, this characteristic is due to the insulating nature of the paper pulp used and to the slowness with which heat transfer takes place through the walls of the container, even when directly exposed to the sun. Bottomless, bottle-shaped, paper-pulp covers are made that can be slipped over the filled bottles left by the milkman. These covers, with the intervening air space, provide still greater insulation against heat, and thus insure the milk being kept cooler than would be the case in ordinary circumstances. Needless to say, paper-pulp milk bottles are filled and capped by the same dairy equipment now used for glass bottles.

Some of our readers may be disposed to wonder whether or not a paper-pulp bottle would not be softened by its contained fluid. We are informed that milk bottles and other containers made from paper pulp can be thoroughly waterproofed by means of certain materials incorporated during the beating of the pulp. Therefore, they come out of the Drake machine and drier ready for use—waterproof, bacteria proof, and sterilized. Such containers would hold cold water or milk for weeks without softening or without receiving any foreign flavor from the bottles. They may be given an oil-proofing treatment in addition—inside and out; and containers so prepared have held lubricants for six months or more.

Having described the various commodities so far produced in the Anacostia plant of the Pulp Products Corporation—the establishment began operations only as recently as July 1 of the present year—let us now follow the different stages by which newspaper is turned into boxes, bottles, and pots. Whether the old newspapers are delivered at the plant by enterprising youngsters or by ordinary dealers in that material, the basic scrap is put into regular paper-mill beaters where, softened by admixture with a suitable volume of water, the newsprint is macerated and reduced to pulp and conveyed to "stock chests" for dilution and storage. Thence it is fed directly to the Drake automatic molding machine. While in the beater, the pulp is colored, if so desired, or left unaltered for the making of pearl-gray products from printed paper and creamy-white ones from blank paper. From the feed tanks of the molding machine the pulp drops by gravity into the molds. Each machine has connections for ten molds; and it is possible to change any or all of them agreeably to the commodities to be made at any time by the apparatus.



Berry baskets, milk bottles, flower pots, etc., made from paper pulp by the Drake process. The mold used in forming the flower pots is shown at bottom center of the picture.

The feed tanks on top of the molding machine are filled with pulp made up of 99 per cent water; and the amount of pulp fed to each mold is automatically regulated by a timing valve—thus insuring uniformity in the quantity entering the mold. The volume of pulp naturally varies with the size of the product to be made. So far so good, but before following through the succeeding operations let us pause for a moment to consider the molds, themselves, because each of these, in principle, is a small paper-making unit of an extremely simple sort. Each mold is composed essentially of five parts—four forming the sides and one the bottom. All are so hinged that their joints become airtight when closed; and they swing open so as to discharge the containers formed within them. The four bronze sides are perforated, and each is lined with a rustproof wire gauze of monel metal. This gauze represents the

screen of the usual paper-making machine upon which a pulp film is spread that afterwards becomes paper when successively passed through pressure and heating rolls.

As soon as a mold is closed, a charge of paper pulp is injected into it through the timing valve; and with this done the valve closes. Instantly thereafter compressed air, at a pressure of 65 pounds, is blown into the mold. This air has been previously heated to a temperature of 650° F. In a fraction of a second, the compressed air distributes the pulp upon the sides and the bottom of the mold in a uniform film—forcing a large share of the water content outward through the perforations in its walls. The heat of the compressed air also serves to partly dry the pulp and to sterilize the newly formed container. The product remains in the mold for 30 seconds—dropping out at the end of that period, when the mold opens. At that instant, the commodity contains 60 per cent moisture, and is sufficiently rigid to be handled and placed in trays preliminary to entering the drier—the trays being stacked five high on small-wheel trucks for this purpose.

Anacostia plant of the Pulp Products Corporation.

The compressed air used in the molding machine is kept at the desired temperature by a separately fired Foster superheater—the primary source of heat being Johnson oil burners. Air from the compressor goes to heating coils in the superheater on the farther side of a fire wall, and is conveyed thence to the molding machine. Air for the drier is heated by Aerofin coils utilizing steam at 5 pounds pressure from a Heggie-Simplex boiler, and is distributed by a Sturdivane fan at a ¼ inch water pressure. The operating principle calls for a large volume of air at low pressure and low temperature. A matter of 10,100 cubic feet of hot air is sent through the drier every minute; and an expenditure of only 2.3 hp. is required for moving this air.

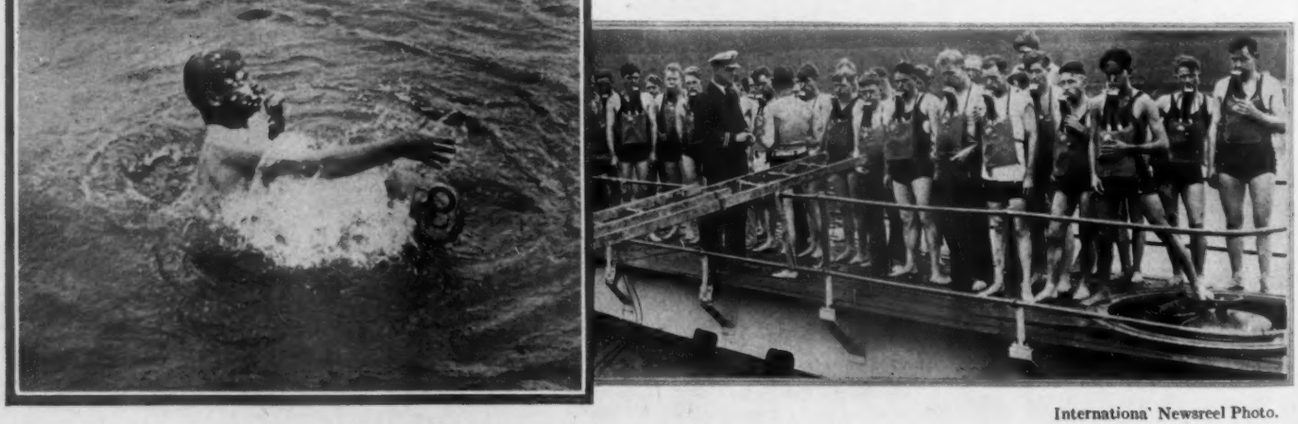
The products, with their contained 60 per cent of moisture, enter the drying room at its cooler end, where the temperature is 105° F., and move gradually toward the hotter end, where the temperature is 148° F. This procedure gradually vaporizes the moisture imprisoned in the containers and effectually prevents the distortion of the commodities, which would take place if the moisture were heated so as to induce it to escape forcibly. Upon issuing from the hot end of the drying room, the products have a moisture content of only 10 per cent. This is low enough for all practical purposes. The seamless containers remain in the drying room normally for a period of 1½ hours—the interval from raw stock to finished condition, ready for shipping, being a matter of only three hours.

At the present time, the molding machine consumes about 340 cubic feet of air per minute. The primary energy is electricity; and the motors in the plant aggregate 200 hp. Current is purchased at 13,200 volts and is transformed on the premises to 440 volts. The transformer room is said to be unsurpassed by any other transformer installation in the District of Columbia.

Mr. R. P. Johnston, plant manager, estimates that the factory, with its present equipment, will be able to turn out 30,000,000 pieces a year—working 24 hours a day and 5⅓ days a week. One especially interesting thing about the operation of the establishment is that there is no waste of raw materials—imperfect or damaged products are merely returned to the beater and reworked for re-use. This utilization of old newsprint opens up a tremendously wide field of possible service, because the same basic stock can be employed to fashion an almost endless variety of commodities.

ADDING TO THE SAFETY OF SUBMARINE SERVICE

THAT they may do their work with the assurance of a greater measure of safety, the officers and men of submarines in the United States Navy have been outfitted with oxygen-breathing apparatus, familiarly known as "the lung". This device operates on the same principle as the breathing apparatus now used extensively for fire-fighting and for mine rescue work, and, in case of accident, will permit the crews to abandon a sunken submarine and to rise or, more literally, to "shoot" to the surface little the worse for their experience. This has been conclusively established during the past months in which "the lung" was put through a series of exhaustive tests. These tests were brought to a successful climax when 26 officers and bluejackets, so equipped, escaped by way of the after hatch of an underwater craft submerged for the purpose and rose to the surface.



Left—Emerging successfully from a sunken submarine with the aid of "the lung". Right—Lieut. C. B. Momsen, co-inventor of the lung, instructing a submarine crew in the use of the apparatus which will enable them to rise to the surface in case their craft should founder.

International Newsreel Photo.

Compressed Air Builds New Baffles

PLANT managements are always interested in anything that will help to bring about savings. Therefore, the following baffle-replacement job by the boiler-room crew of the Essex Rubber Company, Trenton, N. J., is worth describing. The following particulars have been furnished by Mr. William E. Smith, the company's chief engineer.

The tile baffles in three of our 250-hp. Edge Moor boilers were leaky, as indicated by stack temperatures averaging 600° F. The baffles had been in use for some years, and were found to be in a condition necessitating their renewal both front and back. Estimates showed the cost of replacement to be $1,200. This figure we thought we could trim materially by having our own men make monolithic baffles. We believed that we could do this by forcibly blowing a plastic mixture directly against a framework or lattice fashioned of wood.

The Quigley refractory gun charged and ready for the baffle-building operation.

We had in our plant a refractory gun originally ordered on trial for use in patching and repairing furnace walls and arches. It served so well for these purposes that we decided to try it in building the necessary baffles. We called in the service engineer of the Quigley Furnace Specialties Company, the manufacturer of the gun, and were not only told that the plan was feasible but he demonstrated the fact by making with it the first of the monolithic baffles.

Compressed air is utilized to operate the gun—the pressure required depending upon the character of the mix applied. Thin mixtures have been placed with air at 50 pounds pressure; but for plastic refractories pressures of from 70 to 90 pounds are needed, as shown by the accompanying chart of a typical test run with a charge of 2 cubic feet—the capacity of the gun. This material was sufficient to cover an area of 100 square feet with a coat ¼ inch thick, and was shot in place in about six minutes—the air pressure during that interval mounting from 86 pounds at the start to a maximum of 91 pounds. The amount of air consumed varied from 121 to 135 cubic feet per minute.

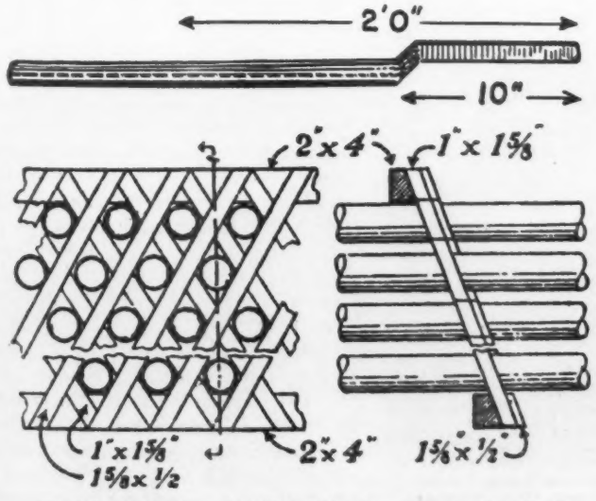
As our plant is amply equipped to provide air at 90 pounds pressure, we were able to construct the baffles without difficulty under my supervision. We proceeded as follows: 2x4-inch wood stringers were laid across the tubes to support the lattice work of 1x1⅝-inch slats which were placed diagonally down each lane between the tubes, with crossed diagonal slats down each lane from the opposite direction. These slats were fastened to the stringers across the top and beneath the bank of tubes. In this manner we built the forms for the front and the rear baffles of the three boilers—six baffles in all.

The high-temperature cement used was first diluted with water, bringing it to a consistency of a creamy batter. Then we added the dry refractory material, a little at a time, mixing it all very thoroughly. When about ready to apply, a small amount of Portland cement was put in the mix to aid the initial set. This plastic mass was somewhat stiffer than mortar and was made in several batches so that it would always be in a sufficiently moist condition.

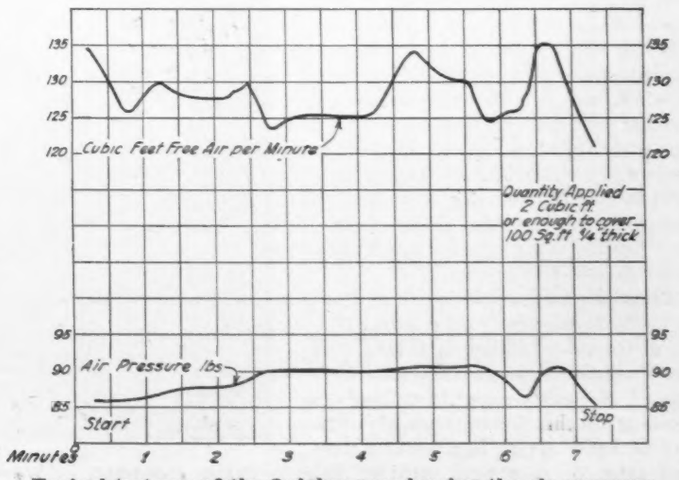
Commencing at the bridge wall, we shot the mixture from the gun against the lattice—the short nozzle used being lengthened with sections of ¾-inch pipe as the work progressed. With the material in position we tamped it with a special tool made of ½-inch pipe flattened at one end for about 10 inches—the flattened part being offset about 2 inches. By utilizing extension sections of ½-inch piping we could reach up through the lanes of tubes to any point. With this tool we could not only tamp and smooth the surfaces of each baffle but, by turning it on edge, also work the material snugly in and around the tubes.

We did not build the separate baffles to full thickness at one time, but alternated between the front and the rear baffles so as to give each successive layer an opportunity to dry out slightly and to set before applying the next one. Soon after the baffles were finished, a slow fire was started to dry them out, and about eight hours later the boiler was raised to steaming temperature. The wood lattice was left in place and allowed to burn away.

We were surprised at the speed with which the work was accomplished and to find that we had done a satisfactory job at low cost, as follows:



Sketches showing details of the tamping tool and of the baffle form.



Typical test run of the Quigley gun showing the air pressures and the time required to apply the refractory mix.

4,200 lbs. dry refractory material and 3,200 lbs. Hytempite	$226.70
1 bag Portland cement	.70
200 feet of lumber	24.00
55 hrs. of labor at $1 per hr.	55.00
55 hrs. of labor at $0.62 per hr.	34.10
Total cost for the six baffles	$340.50

As compared with the original estimate on the job, this figure represents a saving of $859.50—enough to pay for the gun and to leave a margin of $234.50 besides.

The new monolithic baffles are gas-tight and enable us to operate these hand-fired boilers on an average of 135 per cent of rating over 24-hour periods with peaks as high as 180 per cent. They have also brought our average stack temperatures down to 495° F. at this rating with 560° at the peaks, indicating a good, tight baffle job that has effected a considerable saving in fuel.

These portable compressors provided the air needed to operate a large pneumatic hammer used to drive to hardpan a number of large steel tubes forming part of the foundation of an armored vault in lower Manhattan, New York City.

UNDERPINNING A LARGE ARMORED VAULT

ANYTHING unusual in the streets of New York can always be counted upon to attract a crowd of noonday pedestrians, and interest grows directly in proportion to the unexplained reason for the object of their curiosity. It was just this that happened not long ago when two large portable compressors, hooked up to a single capacious receiver, appeared at the curb just outside the towering office building of the Standard Oil Company, where Broadway and Beaver Street meet. Manifestly, the two machines were there to charge the receiver with compressed air, and it was equally plain that the air was being drawn off from the receiver by a pipe leading into the building on the ground floor occupied by the International Germanic Trust Company. But what was being done with or by that air at the other end of the main? That was the thing that puzzled the lunch-hour walkers.

The service to which the air was being put was in nowise mysterious even though the general public was not purposely taken into the confidence of the trust company. That concern, after it got into its expansive quarters, found it necessary to make some changes in order to equip itself properly for the conduct of its business—it needed, among other things, a large vault in which to house securities safely. To do this, and to provide the armored chamber with suitable support, entailed excavating an area of 50 x 60 feet to a depth of 24 inches, and then driving around the perimeter of this area—down to hardpan—24 steel tubes each 12 inches in diameter and 16 feet in length.

Before the tubes could be driven, it was necessary to clear away the concrete flooring of the office building, and this, as already mentioned, was 2 feet thick. Compressed air was utilized in drilling and breaking up this flooring throughout the area of 3,000 quare feet. The hollow, steel tubes or piles were fitted at their lower ends with pointed heads of sufficient strength to penetrate the ground—the work of driving them being done with a No. 7 McKiernan-Terry air hammer. The purpose of the two 10 x 8-inch Ingersoll-Rand portable compressors was to provide power to operate the hammer. After they had been driven to the required depth, the upper end of each pile projected above the surface of the ground for about 12 inches. When in place, each pile was filled with concrete.

The Foundation Company did the pile work. Operations were carried on only at night so as not to disturb tenants in the skyscraper during the daytime; and the job was completed within the brief span of five days.

International Newsreel Photo

Frank Salisbury, of Waverly Hills, Va., and his model airplane which is driven with compressed air.

NOTABLE AIRBRAKE TESTS NEARING COMPLETION

WHAT are said to be the most exhaustive airbrake tests ever made under actual service conditions anywhere are now in progress in the United States and are being conducted by the railroads under the auspices of the American Railway Association. The object is to determine what additional improvements can be made in the airbrake system to promote still greater safety, efficiency, and economy of operation and to meet the requirements imposed by the faster-moving trains of today.

The road tests will take about a year to complete and mark the closing chapter of painstaking investigations that have been underway since 1925 in a specially built laboratory at Purdue University, Lafayette, Ind. That work, which was brought to a close early in 1929, included experiments not only with airbrakes such as are now in use but also with newer and improved types.

The scene of the present tests is the Shasta Division of the Southern Pacific between Hornbrook, Calif., and Eugene, Ore., a distance of 260 miles. This line was selected as the one most suitable for the purpose—the gradients between terminals ranging all the way from level stretches and long, moderate climbs to heavy mountain grades. Two hundred tank cars, fitted with airbrakes of different makes, are being used, and these are made up in 50-, 100-, and 150-car trains. Carrying loads equivalent to those normally hauled, the trains are run under every conceivable operating condition.

When completed, these truly notable tests will have cost the railroads of the United States and Canada in excess of $2,000,000. Large as this sum may seem, it will not have been spent in vain if the outcome is a power brake that will meet the needs of our railroads for many years to come.

Bingham Canyon's Great Copper Camp

Mining Methods Used at Bingham in Making the Low-Grade Deposit Commercially Profitable

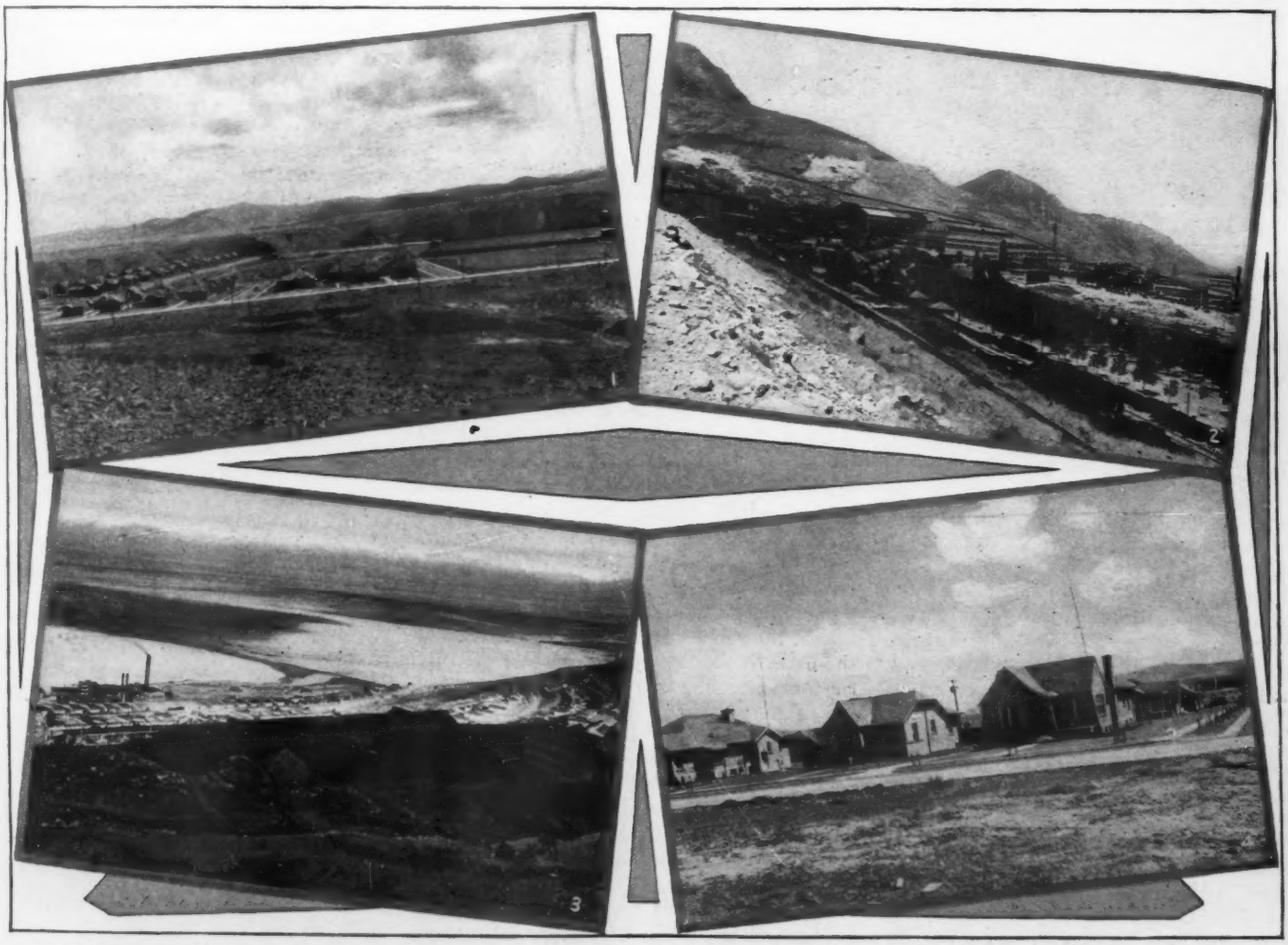
PART II

By R. G. SKERRETT

HOW now shall we picture the wonder mine of the Utah Copper Company so that persons that have not visited Bingham shall have at least an approximate idea of its magnitude and its uniqueness? The task is a difficult one because, in the last analysis, the mine beggars description. It is not enough just to say that the property is the largest open-pit copper mine in the world; nor do most of us get much out of the fact that the mine has a superficial area of a trifle less than 1,000 acres. The thing has to be seen to be appreciated, and then one realizes the inadequacy of words in dealing with that titanic hill and its ore reserves of 625,000,000 tons—a mass of monzonite porphyry carrying an average of 1.066 per cent of copper per ton of rock.

For lack of a better term, the mine may be described as a triangular headland, flanked by two deep canyons or gulches, which, viewed from certain points, presents the appearance of a monster terraced pyramid that rises to a height of 1,700 feet above the lowest point of the visible workings. These terraces or operating levels—often called benches—vary in height from 50 to 125 feet, with an average interval of 69.5 feet between them. Inasmuch as there are 26 of these levels or benches, and each broad enough for the running of ore trains and the working of large power shovels, the impressive proportions of the undertaking become realizable.

Viewed from the opposite slope of either of the flanking valleys, the mine loses none of its splendid stature; but power shovels and ore trains dwindle to the size of mechanical toys, and the 2,000 and more human operatives become correspondingly diminutive and much harder to discern as they go about their various tasks. The whole thing is an amazing example of what the audacity and the persistence of relatively puny man can accomplish when confronting Nature in a grand and austere mood. The mine is a monument to the courage and to the engineering skill of the men who conceived the mining method employed and then devised the ways that have



1—A wide view of the Town of Copperton which the Utah Copper Company has called into being for the benefit of its employees engaged in Bingham Canyon. The location is a healthful and an attractive one. 2—The Arthur Mill, on the shore of Great Salt Lake, which prepares much of the ore for subsequent smelting. 3—The Magna Mill, also on the shore of Great Salt Lake, which shares in preparing for the smelter the ore mined in Bingham Canyon. 4—Near view of typical homes reared by the Utah Copper Company at Copperton for the housing of its employees.

1—An electric shovel loading waste on one of the benches. The size of the shovel is a good index of the magnitude of the undertaking. 2—Electric locomotives have been found especially suitable in handling loads on the steep grades that have to be negotiated at the mine in Bingham Canyon.

so successfully harvested many millions of dollars worth of red metal from ore carrying only a low percentage of copper.

Before touching upon certain phases of the mining operations that have made Bingham so richly productive, let us consider the deposit briefly as a geological formation that owes its origin to a remote past. Deep strata of limestone and sandstone once overlay the region long before Bingham Canyon and Carr Fork were carved by erosive action and the bedding planes disturbed by the upward thrust of plastic magma seeking an outlet surfaceward. When that molten or plastic flow pushed upward it exerted sufficient energy to displace and to shatter the superposed older rocks, and the resultant heat and pressure transformed the limestone into marble and the sandstone into quartzite, fracturing these in turn so as to produce fissures and faults into which the mineral-bearing magma could penetrate. Upon nearing the cooler areas adjacent to the surface, where pressures also dropped, the metals were precipitated out of solution, and thus the deposit was primarily made—the mass as a whole carrying so little copper per cubic yard of rock that it would not warrant the cost of mining if it existed as such today. However, succeeding ages and the joint actions of air and water wrought a miracle of enrichment.

Oxidation in the course of time increased the porosity of the rock from the surface downward, and this, in combination with the widespread fractures induced by the original intrusion of the magma, provided channels for descending seepage following rains and melting snows. This water dissolved copper sulphates and carried them deeper and deeper into the mountain—gradually building up an underlying body of enriched ore. In other words, the copper coming from the bowels of the earth in the first place was added to by copper descending from the upper portions of the primary deposit. In this fashion time—untold time—slowly but surely worked a change that was to prove a boon to man when copper became essential to him for many purposes; and man, in his turn, is now digging inward and downward to garner the treasure stored in that mountainous mass ages and ages ago.

The Utah Copper Company began its work at Bingham in 1904 with underground tunneling and caving; and this method was held to for substantially the better part of three years. The underground work was to a large extent exploratory in purpose—the aim being to combine production with the proving of the property. Core-drilling from the surface during the same period revealed the thickness of the overlying oxidized "cap", from which the original copper has been largely leached by rain and snow water; and the cores also disclosed the fairly uniform distribution and concentration of copper in the rock below. The cap which has to be cleared away before worth while ore is reached, is composed of an overburden of a few feet of earth beneath which there is an average of 115 feet of monzonite from which the original copper content was removed by Nature's protracted period of leaching. It is because of this cap that 1 ton of waste rock must be quarried for every ton of copper ore mined. Core-drill holes have been sunk to a depth of 1,800 feet; and the ore body is known to extend 1,000 feet below the lowest of the present surficial workings. In short, at the current rate of production, there is enough pay ore in reserve to warrant working the mine for half a hundred years to come! This is a vast deal more than Colonel Wall probably imagined in his most optimistic moments.

In August of 1906, the Utah Copper Company changed from underground to open-cut mining or quarrying, and then put its first steam shovel to work gnawing away at the mountainside. This system has since been progressively developed and amplified. Today, ore is being mined at 22 levels on the west side and at four levels on the east side; a total of 60,000 tons of ore is being taken out every 24 hours; and from this ore there is being produced daily a matter of 1,000,000 pounds of copper. Expressed otherwise, Bingham is providing the world with one-twelfth of its supply of the red metal. The total amount of material moved from the mountain up to December 31, 1928, was 372,086,656 tons, including both capping and ore. A maximum of 141,586 tons has been mined and hauled away in the course of a day. This was done on May 9 of the present year. That tonnage is sufficient to fill 2,831 cars, each of 50 tons capacity. Allowing a length of 40 feet for each car, they would make a single train 21.4 miles long—that is, long enough to fill the tracks between the mine and the mills where the ore is treated on the shore of Great Salt Lake—and leave an excess of more than four miles.

Now for a brief summary of the way in which the mountainside is drilled and blasted and the broken materials are then disposed of and carried away to convenient dumps or hauled to the mills located at Magma and Arthur, Utah, where the ore is crushed and a concentrate finally produced containing 30 per cent copper—the concentrate going thence to a convenient smelter at Garfield, Utah, also on the shore of Great Salt Lake.

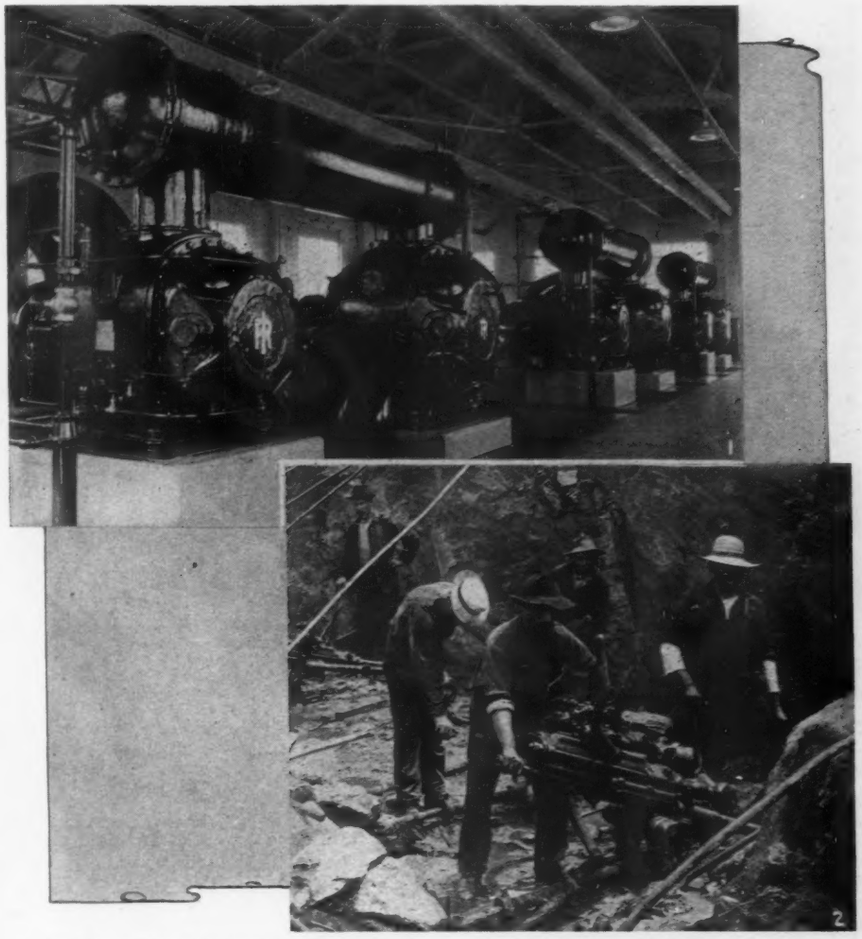
While the first steam shovel began its open-pit work in 1906, it was not until March of the following year that any copper ore was so produced—the interval being occupied in stripping the ground of the earth and the leached or low-grade ore constituting the so-called cap. For two thoroughly sound reasons

the terracing or benching was begun at a low level instead of doing the seemingly logical thing of starting at the top and working downward. The reasons for this were: First, the Utah Copper Company was not at that time the owner of the top of the mountain; and, second, to have begun high up would have involved the removal of much non-paying material and a rather long postponement in getting out profitable ore. Therefore, in order to limit to a minimum the amount of working capital needed, the procedure mentioned was adopted; and, while the shovels were clearing away the cap, underground mining was continued for the purpose of extracting ore that could be milled immediately and which would yield an operating revenue.

At that time, Robert C. Gemmell was appointed general superintendent; and the steam-shovel work was put in the capable hands of J. D. Shilling, Sr. Today, J. D. Shilling, Jr., is the superintendent of mines. It is interesting to record the fact here that the experts of some other companies declared the restricted formation of the canyon to be such as to make the employment of steam shovels inadvisable, but that Messrs. Jackling and Gemmell thought otherwise and followed the dictates of their own judgment. Results have since amply confirmed the wisdom of the means and methods used.

The face of the mine at each level or bench has an average slope of 50 degrees, and the ore is brought down by drilling two sets of holes, called, respectively, toe holes and bank holes. This work is done with Ingersoll-Rand F-24 piston drills—the bits having a diameter of 3¾ inches at the start and a diameter of 2¼-inches at the bottom of the holes. A footage of about 45 feet is drilled each shift. The toe holes are drilled at an angle of from 5 to 15 degrees from the horizontal and are spaced generally 15 feet apart. The average depth is 22 feet. The bank holes are not spaced with any regularity but are drilled wherever needful to bring down any masses of rock that project from the face of the mine after the toe holes have been fired. The depths of the bank holes vary with the size and form of the mass of rock to be brought down by them.

The inclined holes are chambered to a size large enough to accommodate the blasting charge, which averages 185 pounds to the hole. The chambers are formed by springing the holes from four to seven times—the condition of the rock determining the number; and the loading is done through a 1½-inch pipe to insure the charge of 40 per cent dynamite reaching the bottom of the hole. This procedure is necessary because of the angle of the hole and because it may be jagged. The pipe is withdrawn before blasting. The usual custom is to do the blasting during the noon hour—the firing starting at the lower levels and following upward. Readiness is indicated by a certain number of blasts sounded by the shovels on the several levels. When the last of the levels has thus given notice of its readiness, then a large air-operated siren gives a final series of warnings, and before the last of these the workmen on the benches seek cover in conveniently located bombproofs.

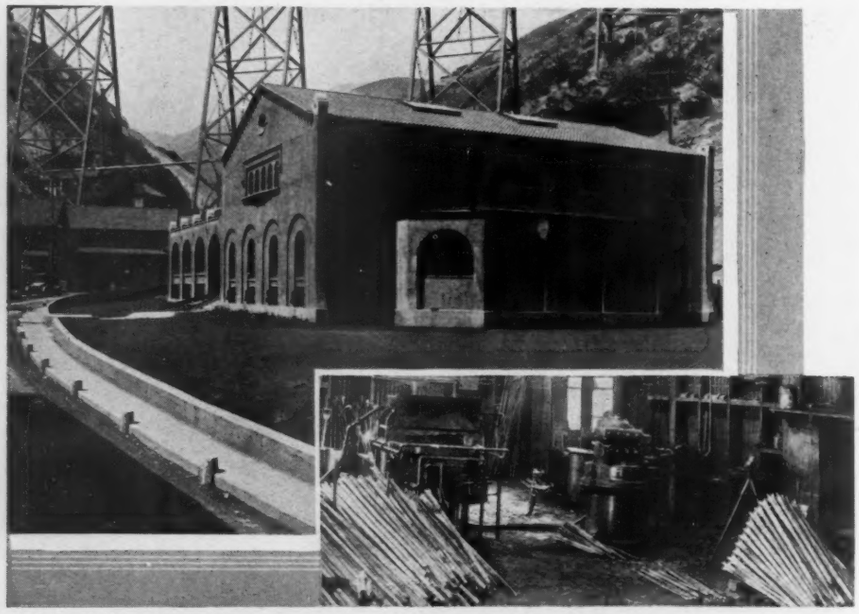


1—These three 24-inch PRE-2 compressors furnish motive air for various purposes in and about the mine at Bingham. 2—One of the numerous I-R piston drills in service in the Utah Copper Company's great mine.

Two drilling crews operate with each power shovel; and a crew is composed of a drill runner, a helper, and a bankman. One crew precedes the shovel and works mainly on the muck pile block-holing large pieces of rock so that they can be handled by the dipper; and the other crew follows the shovel and drills the toe holes for the next main blast. Block-holing is done with "Jackhamers". According to Mr. E. E. Barker, engineer of mines, the blasting charge is at the rate of 1½ cents a ton, while the combined cost for labor, drilling, compressed air, powder, other operating supplies, and repairs does not exceed 2.6 cents per ton of rock quarried. All the deep-hole drilling required to bring down 60,000 tons of ore daily is done with approximately sixty F-24 drills. Because the rock has a tendency to cave, and, therefore, is hard to drill, the average performance of a drill is two holes a day.

Compressed air for running the rock drills is distributed from a central power house through a pipe line on each terrace or level. The new air plant, recently equipped, contains three large Ingersoll-Rand machines: one of 3,500 cubic feet capacity, and two each of 4,000 cubic feet capacity. Besides operating rock drills, compressed air is used to run pneumatic tools in two machine shops, to blow whistles, to test air brakes, and to do various other helpful services.

Prior to 1924, all power shovels used in stripping and mucking were steam operated, but during 1924 a few electrically driven shovels were purchased and put in service to test their adaptability for work at Bingham. Since then, the steam shovels have been entirely supplanted by electric shovels, all of which are equipped with caterpillar tractors. So fitted, the shovels become automotive and obviate the laying and shifting of track for their use—thus lowering the cost of operation. There are 23 of these power shovels employed on different levels; and each is large enough to transfer at a single swing of the dipper as much as 7 tons of ore. The shovels load the muck cars—ranging from 30 cubic yards to 40 cubic yards in capacity. The smaller cars carry off the stripping to the dumping levels while the larger cars convey the ore to an assembly yard preparatory to being hauled to the Magna and Arthur mills. Inasmuch as the terraces range from 40 to 250 feet in width, there is plenty of room for the movement of these trains and the operating of the power shovels.



Top—Gemmell Club House erected in Bingham for the pleasure and convenience of the employees of the Utah Copper Company. Bottom—A corner of the well-equipped blacksmith shop where the drill steels used in the mine are conditioned and sharpened.

On the working levels on the two sides of the mine there are substantially 75 miles of railroad track and connecting switchbacks; and the locomotives are required to negotiate slopes having gradients of as much as 4½ per cent. Trains in the ore service are made up usually of twelve ore cars while those in the waste service consist of 5 or 6 dump cars. Most of the hauling immediately about the mine is done with standard-gage dinkey steam engines, but the intention is to substitute electric locomotives; and there will soon be 53 of these machines in use at Bingham. The ore trains that move between the mine and the mills seventeen miles away are pulled by powerful Mallet steam locomotives. These trains descend 2,000 feet in going from the assembly yard at Bingham to the bottom of the valley on their way to the mills; and, to make certain that the train lines and the brakes are in proper condition for the journey downward, they are tested with compressed air before leaving. How much wear and tear there is on that equipment can be gathered from the fact that a set of brake shoes will last for only two round trips!

According to the figures for the calendar year of 1928, a total of 16,558,500 dry tons of ore was mined and shipped to the mills during that twelvemonth. The average copper content of the ore was .992 per cent, or 19.84 pounds per ton; and the average recovery in the form of concentrates was 16.97 pounds of copper per ton of ore. That is to say, the concentrates shipped to the smelter held 281,077,725 gross pounds of copper. Precipitates derived from mine and waste-dump waters contained 1,976,851 pounds of copper; and after deducting smelting and refining losses, the net production of refined copper from the ore mined at Bingham last year amounted to 273,823,351 pounds.

In his annual report for 1928, Mr. Louis S. Cates, vice-president and general manager, has made the following very interesting general statement:

"In an operation of such magnitude, it is interesting to review the forecasts of those who conceived this development, and particularly so at this time to compare some of the operating figures of 1928 with those set forth in the first comprehensive engineer's report made on these ore deposits and dated September 18, 1899. In that report, which first recognized the commercial possibilities of this type of low grade copper ore deposit, it was estimated that the direct cost of mining and stripping would be 54 cents per ton of ore; for the year 1928 the mining cost, including stripping and a proper proportion of fixed and general charges, amounted to 31.78 cents per ton. This early report estimated the cost of transporting ore to mills as now located at 15 cents per ton: for the year just closed the ore was delivered from the mine to the mills at a cost of 8.74 cents per ton. Again, it was then estimated that the direct milling cost per ton would amount to 45 cents: the result for 1928, which includes all charges, was 36.9 cents. It was also estimated that the actual cost of producing copper would be 6 cents per pound, based upon an average copper content of 2 per cent: for the year just closed the average assay of ore treated was .992 per cent copper—slightly less than one-half the figure used in the original report, but the cost, exclusive of depreciation, was 6 cents per pound.

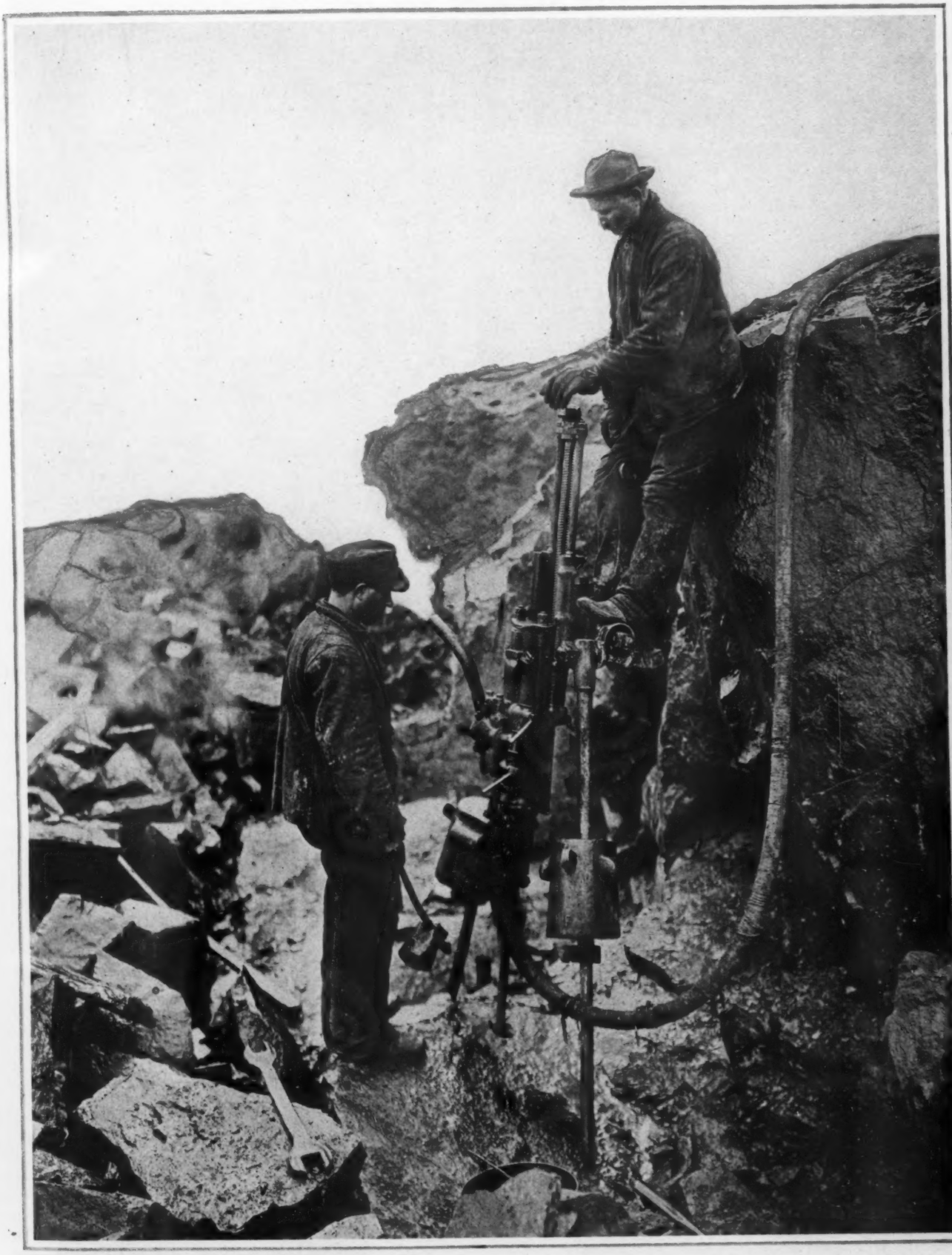
Photo, Underwood & Underwood, Inc.

Louis S. Cates, vice-president and general manager of the Utah Copper Company.

"These facts illustrate the economic effect of operations on a scale unprecedented prior to the inauguration of this enterprise and emphasize as well the advancement in means and methods, both technical and practical, which have altogether made it possible, in the face of increased unit costs of every kind, and particularly so as to labor, supplies and taxes, to operate profitably on an ore of only one-half the value originally considered and thereby, in large measure, to increase basic reserves of profitable raw material more than thirtyfold as compared with the early estimates of the commercially available tonnage."

While the Bingham property of the Utah Copper Company is usually considered solely as a source of copper, still every ton of ore mined there contains a small quantity of precious metals—that is, gold and silver, worth thirteen and three cents, respectively. Though comparatively unimportant, as such, these values assume large proportions when they are multiplied by the tremendous tonnage of ore produced annually, and bring to the company a substantial sum each year.

In conclusion, it should be pointed out that the Utah Copper Company pays one-eighth of the taxes of Salt Lake County, including Salt Lake City with its present population of 138,000. Quite 80 per cent of all freight originating in the state is supplied by the mineral industry; and 60 per cent of this freight is dispatched in the equivalent of 40-ton carload lots by the Utah Copper Company. Surely, this is an amazing showing of what engineering skill and splendid management can accomplish with a property that went begging for years because of its isolation, deficiency of water, and the low-grade character of its ore.



Close-up of an F-24 piston drill at work on one of the expansive benches of the Utah Copper Company's mine at Bingham.

NEW MEANS OF TREATING ASPHYXIATION

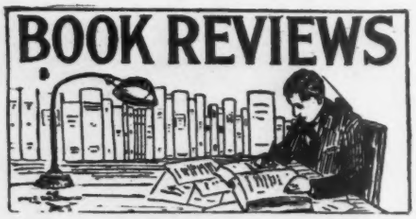
TODAY, the application of oxygen is the best known treatment for different forms of asphyxiation. It has been demonstrated that asphyxiation—the destruction of red corpuscles caused by the action of deleterious gases upon hemoglobin—can be combated by introducing oxygen, under certain pressure, to the poisoned corpuscles. This can be achieved by two methods: By the inhalation of oxygen and by the subcutaneous injection of oxygen.

The first process consists in placing a mask on the face of the victim and, by way of it, causing a fixed quantity of oxygen, at a predetermined pressure, to enter the respiratory organs. This process, however, has drawbacks: it may be responsible for carrying foreign matter—such as dust, tobacco, food, etc.—into the respiratory organs or for serious or even fatal lesions to the pulmonary tissues.

The subcutaneous injection of oxygen is recommended for asphyxiation caused by carbon oxide, fire damp, illuminating gas, or by drowning or strangulation, and may be employed with equal success in cases of fainting, cerebral shock, electrical shock, etc. The basic principle of this method rests upon the fact that the administered oxygen constitutes a gas pocket which is reabsorbed gradually by the body and which immediately begins to purge the intoxicant from the affected red corpuscles. Various apparatus have been devised for the subcutaneous injection of oxygen, but they are intended for the use of physicians only. Generally, they are delicate instruments that are difficult to manipulate and should not be intrusted to inexperienced hands.

However, this method of treating asphyxiation can now be employed safely by ordinary persons, thanks to the development of what is known as the "Hypodermox". This apparatus consists mainly of an oxygen drum, having a capacity of about 4 gallons, which is provided with a gage, a pressure-reducing valve, a safety valve, and with a rubber tube terminating in a hypodermic needle. Its operation is very simple—by closely watching the hands of the gage it is impossible to make a mistake in administering the oxygen; and the needle can be applied to any part of the body. Obviously, "Hypodermox", as a first-aid instrument in the hands of rescue crews, may be counted upon to render invaluable service while awaiting medical help in cases of asphyxiation resulting from one cause or another.

Owing to the increasing demand for chromium, especially in the automobile industry, great interest attaches to the recent announcement, by the Ontario Department of Mines, of the discovery in Canada of deposits of chrome ore. They are located in the Obonga Lake region of northwestern Ontario, and promise to be of commercial importance. At the present time the American market obtains most of its chrome ore from abroad.



OIL ROYALTIES, by Edwin I. Reeser. An illustrated book of 190 pages, published by the Dexter Publishing Company, Tulsa, Okla. Price, $3.00.

THIS volume is very fittingly described as a handbook on petroleum for the layman. The purpose of the author has been to summarize the outstanding facts in the history of petroleum in this country, and to do this in a manner that would make the subject readily understood by the average person. His particular aim has been to tell just what oil royalties are and just what a person immediately or prospectively interested in the topic should know in order to safeguard his present property or potential investments. There is so much worth knowing in the subject—and many phases of it are actually romantic—that this little volume will be found decidedly readable, first because of its topic matter and then because of the way in which it has been handled.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, for 1929, published by The Institute, 29 West 39th Street, New York City. Price, $5.00.

AS usual, this admirable volume contains many ably presented papers dealing with subjects of intense interest to the metallurgical engineer. Limited space makes it impossible for us to try to review any of the topics dealt with. They are of the familiar high standard characteristic of those generally prepared by members of the institute.

THE FORD MODEL "A" CAR, Construction—Operation—Repair, by Victor W. Page. An illustrated volume of 545 pages, published by The Norman W. Henley Publishing Company, New York City. Price, $2.00.

THE Ford car is so familiar as a vehicle that it is understandable why the author has set himself the task of preparing a book that will enable owners, especially of Model "A" cars, to get the most out of their machines by proper operation and by suitable and timely repairs. In order to be in a position to write convincingly on his chosen subject, Mr. Page took one such car completely apart and photographed the various steps followed in taking it down and reassembling it after he had made the repairs needed. These pictures serve as a graphic guide to others bent upon doing the same thing. In addition to practical hints on driving and taking care of a Model "A" car, the book contains no fewer than thirteen chapters that outline in considerable detail the parts of the car and what they do, as well as the repair processes necessary to keep the engine and its auxiliaries functioning properly. The book is primarily designed to help persons largely dependent upon their own skill to keep their cars in condition; and for such the volume should be well worth owning.

CHEMICAL ENGINEERING CATALOG, 1929 edition. An illustrated volume of 1,205 pages, published by the Chemical Catalog Company, Inc., New York City. The price is either $3 or $10—the lesser charge being made to chemical engineers and others engaged in different lines of chemical work.

THIS bulky volume contains an alphabetical list of firms whose products are mentioned in its pages as well as a trade-name index which will be useful in determining the name and location of the manufacturer of a given product. In addition to the foregoing, the Catalog contains a classified index of equipment and supplies; an equipment and supplies section; a classified index of chemicals and raw materials; a chemicals and raw materials section; and a technical and scientific books section, in which are catalogued and briefly described a rather comprehensive list of books in English dealing with chemical and related subjects.

ONTARIO'S MINES AND MINERAL RESOURCES, 1929 edition, issued by the Ontario Department of Mines, Toronto, Canada. An illustrated volume of 101 pages.

THE first edition of this handbook appeared in 1924; the second in 1925; and the third in 1927. The present and fourth edition is the outcome of a great demand for this convenient work which gives a brief survey of the entire mineral field within Ontario. The volume includes detailed information and statistics in regard to the several metals and non-metals, structural materials, and clay products of the province. The authors of the various subjects discussed are listed in the index, but, in the main, officials of the Ontario Department of Mines are responsible for the information under the different headings.

NEW ENGLAND AND THE ST. LAWRENCE SEAWAY, by Henry I. Harriman, President, Boston Chamber of Commerce. A brochure of 152 pages.

MR. Harriman has presented to us in his work what is said to be the most comprehensive and exhaustive study of the economics of the seaway project so far made and bearing specifically upon its relation to New England. The author very appropriately considers the subject from the viewpoint of that section of the country in which he is immediately interested. This does not imply bias, but it does reveal how much New England would expect to gain by the creation or development of a St. Lawrence seaway. Mr. Harriman has taken great pains to seek all available sources of authoritative information; and from the data accumulated by him he arrives at certain significant conclusions. The St. Lawrence seaway would, according to him, mean to New England:

"Lower transportation cost on much of its food supply, hence a lower cost of living. Lower freight rates on many of the raw materials required by its industries. Lower freight rates to many markets for its finished products. A supply of export grain and flour at prices as low or lower than can prevail in other North Atlantic ports, hence a revival in the export business of the port of Boston and other New England ports. The removal of the handicap of rail differentials due to water competition via the St. Lawrence, and a reasonable supply of cheap power."

NEWS - from the Field

TWO EXTREMES -But Both Saving Money

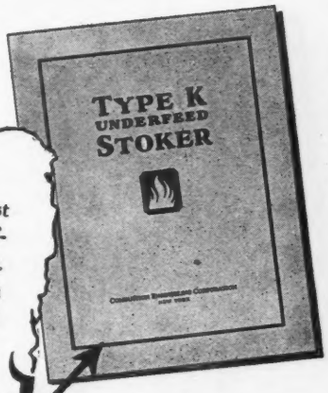
W. M. Park, of Chicago, sends this interesting news:

While in Colorado this week, I visited both our largest and smallest installations in that state. Both plants use Lafayette district coal, mined about 30 miles north of Denver. Locally this is known as northern Colorado lignite, though it is truly a sub-bituminous coal containing 9000 B.t.u. and 25% moisture as received.

The Sterling Hotel at Greeley has our smallest size type K underfeed stoker installed under a fire box type water tube heating boiler. This operates with the absolute minimum of attention but with excellent efficiency.

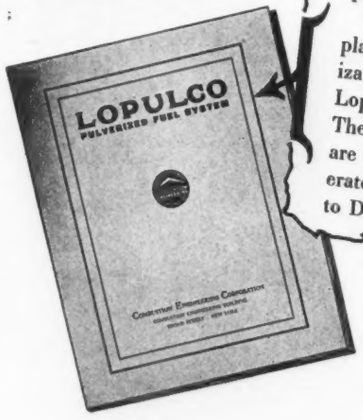
An automatic regulator starts the stoker and fan motor occasionally, the fan running a total of about 20 minutes each hour and natural draft, also under control of the regulator, is sufficient for the low combustion rate at other times. This unit uses the poorest grade of the available fuel, costing $3.10 per ton, and uses no greater tonnage than was required of $4.50 coal formerly used with hand firing.

The other extreme is the Public Service Co. of Colorado's plant at Valmont containing four boilers, a separate pulverization plant with Raymond roller mills and C-E dryers. Lopulco fan-tail burners are used, with excellent results. The boilers are of approximately 1100 h.p. each and three are used to carry 20,000 k.w. load. At present the plant generates 450,000 to 500,000 k.w. hours daily, supplied mainly to Denver.



This new catalog describes the Type K Stoker (the type of stoker installed at the Sterling Hotel) for burning bituminous coal under boilers up to 200 h.p.

The Lopulco Pulverized Fuel System catalog for the storage system describes the system installed at Valmont.



Mr. Park's report shows clearly that lower steam costs are possible for the small power plant as well as the large plant.

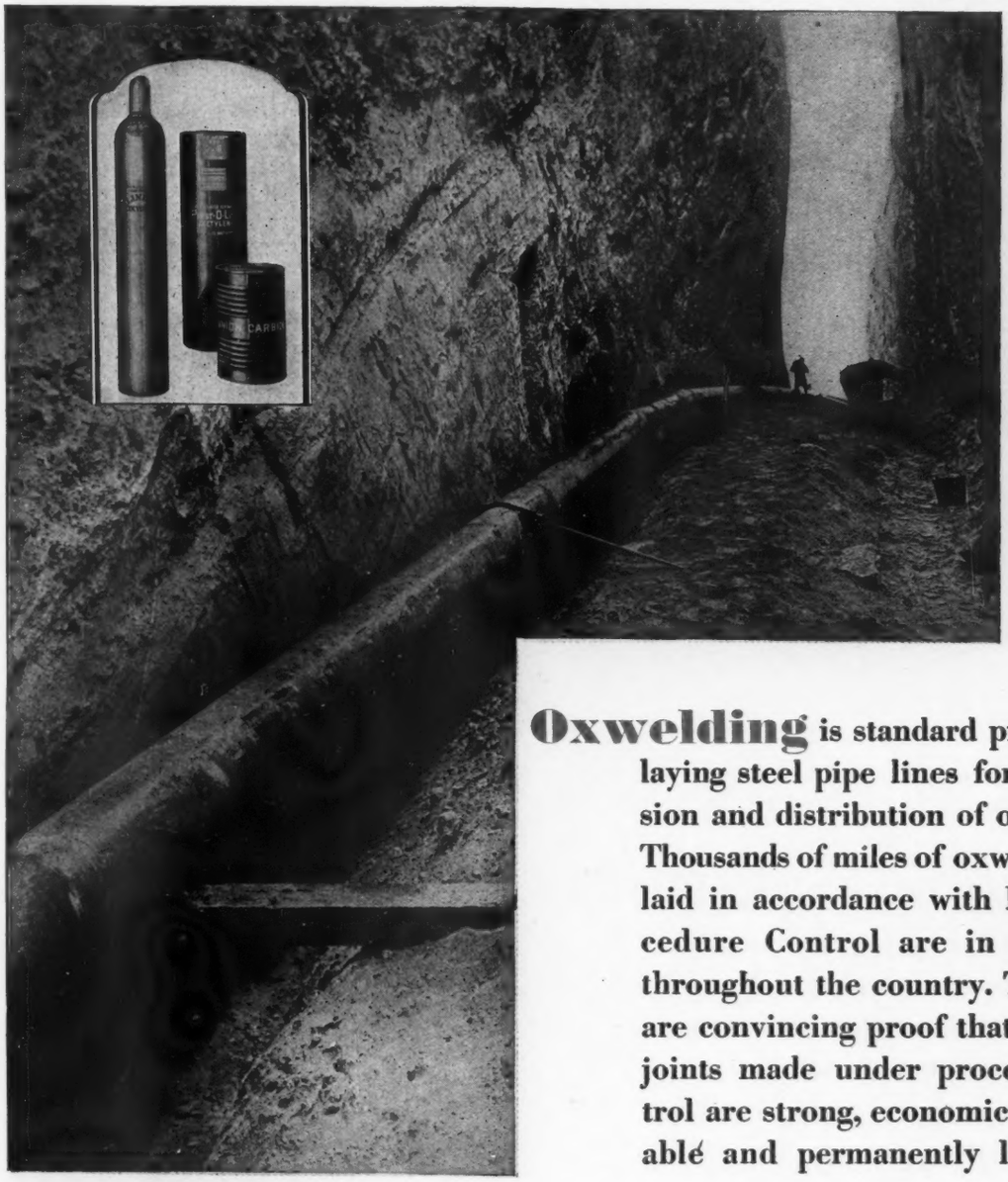
Both of the plants described are equipped with fuel burning apparatus, designed, manufactured and installed by Combustion Engineering Corporation.

COMBUSTION ENGINEERING CORPORATION

International Combustion Building **200 Madison Avenue, New York, N. Y.**

A SUBSIDIARY OF INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

Oxwelded Pipe Lines for Oil and Gas



Oxwelding is standard practice for laying steel pipe lines for transmission and distribution of oil and gas. Thousands of miles of oxwelded lines laid in accordance with Linde Procedure Control are in operation throughout the country. These lines are convincing proof that oxwelded joints made under procedure control are strong, economical, dependable and permanently leak-proof.

Pioneers in Procedure Control for Welding

LINDE OXYGEN
The Linde Air Products Company

Prest-O-Lite
Dissolved Acetylene
The Prest-O-Lite Company, Inc.

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64 Linde Plants—45 Prest-O-Lite Plants—154 Oxygen Warehouse Stocks—138 Acetylene Warehouse Stocks —38 Apparatus Warehouse Stocks—235 Carbide Warehouse Stocks.

Now is the time to put Eveready Prestone, the perfect anti-freeze, in your automobile radiator—Eveready Prestone is guaranteed by National Carbon Company, Inc., unit of Union Carbide and Carbon Corporation.

P & A Photograph

Ride 'Em Doughboy!

Pulling, straining, crashing, slamming, banging, shaking—its all in the day's work to a tank. Think of the stresses and strains that each joint must bear! That's why they trust the job to rivets. The joints must hold.

Some day "the nations will learn war no more" but until then tanks will be built and—well you can depend on riveting.

Speed and uniformity of product are the outstanding reasons why you should use

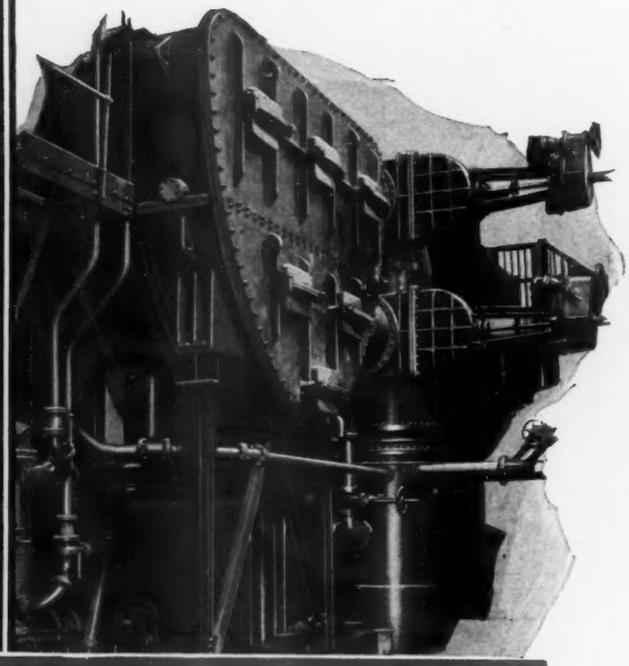
HANNA RIVETERS

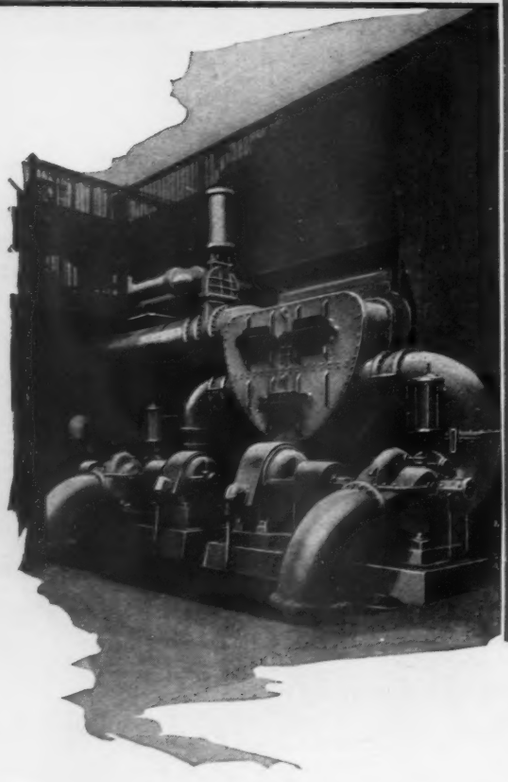
We offer a range of styles and sizes to meet every riveting requirement.

HANNA ENGINEERING WORKS
1770 ELSTON AVE. CHICAGO, ILL.

W-30

The reputation of Ingersoll-Rand is





THE central station has become one of the most important factors in the physical structure of our modern civilization. Upon the absolute reliability of its output depends the industrial, agricultural, and domestic life of the community it serves.

Increased demand has been met by correspondingly increased efficiency and improved characteristics of the operating equipment. And, of course, uniform and unfailing performance has always featured the intricate machinery of the central station.

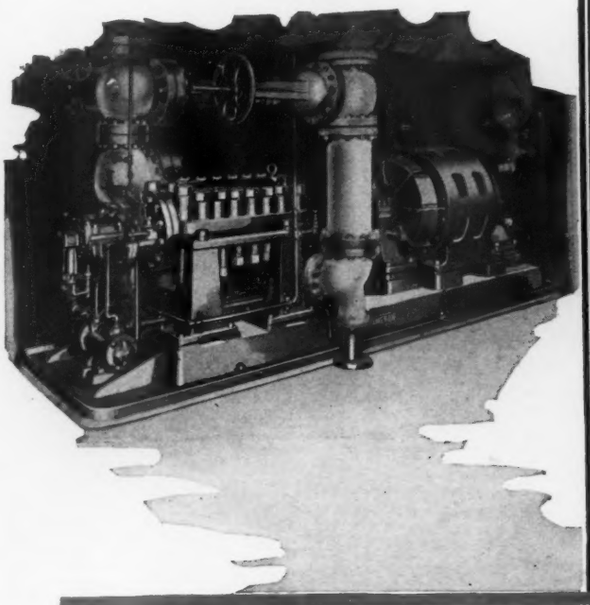
It is to a long list of successful installations in this exacting field that Ingersoll-Rand Company points with pride.

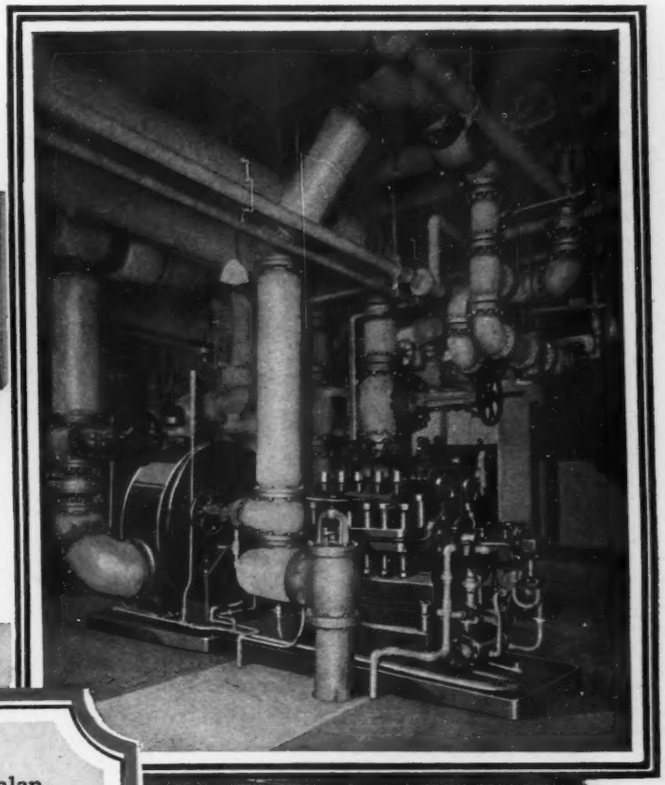
Cameron Boiler Feed Pumps are built for pressures up to 2,000 lbs. and for capacities ranging from 125 to 3,000 gals. per minute.

These efficient pumps have the qualities sought by those who demand a pump above

Typical installations of Ingersoll-Rand Surface Condensers in central stations. In the upper left hand corner are shown the first vertical condensers to be arranged for single pass water circulation. They serve a 100,000 kw. unit.

based on installations such as these



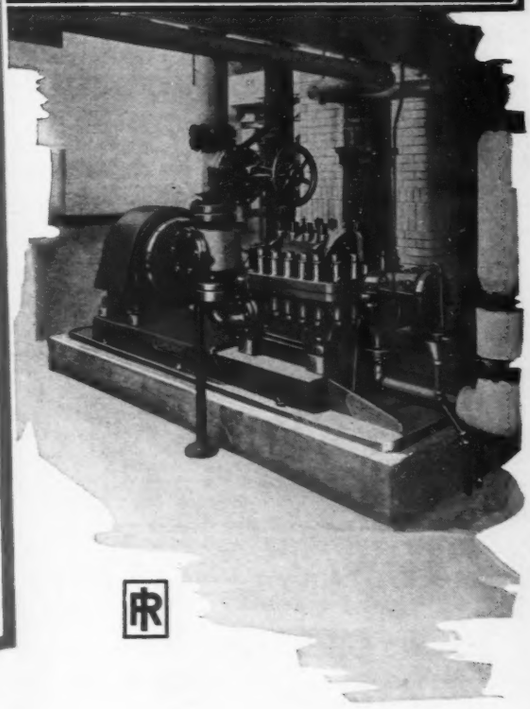


the ordinary. Their lubricating and balancing features are outstanding. Correctness of design is attested by the freedom from thrust and vibration which characterizes their operation.

Ingersoll-Rand Surface Condensers have been built in sizes up to 160,000 kw. and have established remarkable records for efficient performance. Their heart-shaped shell, longitudinal control of steam flow, and external air coolers, result in a high condenser efficiency and a reduction of tube surface as compared with conventional design.

INGERSOLL-RAND CO., 11 Broadway, New York City
A. S. Cameron Steam Pump Works
Branches or distributors in principal cities the world over
For Canada Refer—Canadian Ingersoll-Rand Co., Limited
10 Phillips Square, Montreal, Quebec

Ingersoll-Rand



Cameron Boiler Feed Pumps in three of the country's newest and largest central stations. The pump shown in the upper left hand illustration handles 800 g. p. m. against a total discharge head of 1500 lbs.

R-1967

370-DV

There is a REED AIR FILTER for every Engine and Compressor

REGARDLESS of the type and size of engine or compressor there is a Reed Air Filter designed to meet the specific requirements.

The Reed Type "E" Filter for small portable or stationary equipment—the type SCF composed of one or more standard units mounted in suitable housing ready to bolt to air intake pipe—and the Multi-Panel Automatic where a self-cleaning filter is required.

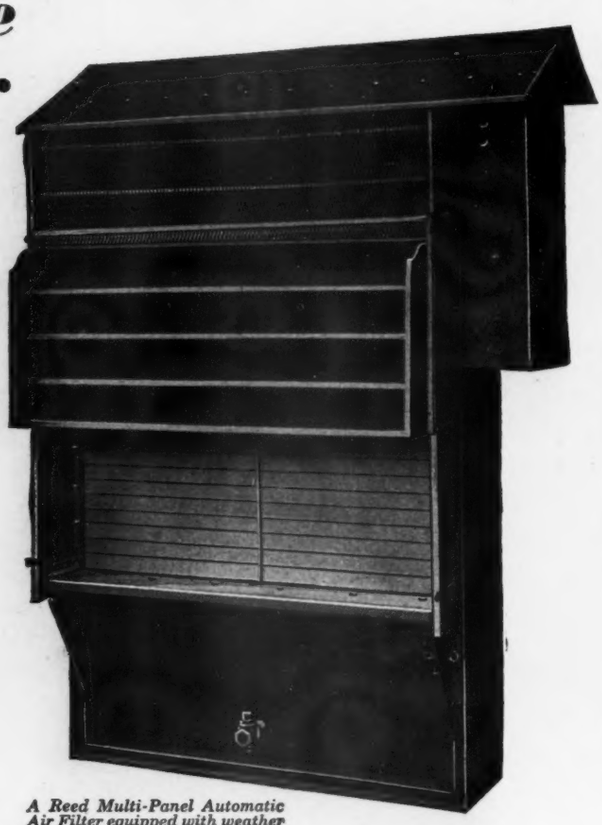
Over 90% of all engine and compressor manufacturers recommend Reed Filters for their equipment—evidencing Reed's outstanding leadership in this field.

Bulletin No. 120 describes the various types of Reed Filters and their application to engines and compressors. The coupon is for your convenience.

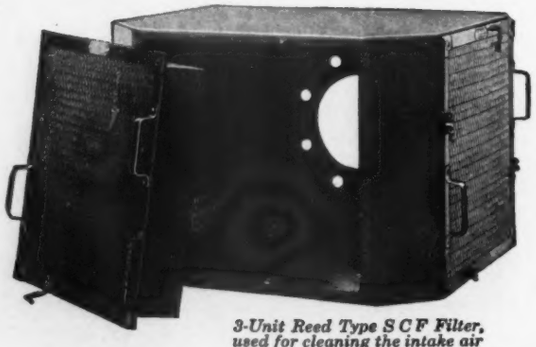
REED AIR FILTER CO.
INCORPORATED
215 Central Ave., Louisville, Ky.

Reed Air Filters

Licensed under American Air Filter Co's Patents



A Reed Multi-Panel Automatic Air Filter equipped with weather housing for outside installation.



3-Unit Reed Type S C F Filter, used for cleaning the intake air on oil engines and compressors.

Reed Type E-1 Filters for small stationary and portable engines and compressors up to 500 C. F. M. displacement.

REED AIR FILTER CO.
215 Central Avenue
Louisville, Ky.

Please send me your Bulletin No. 120

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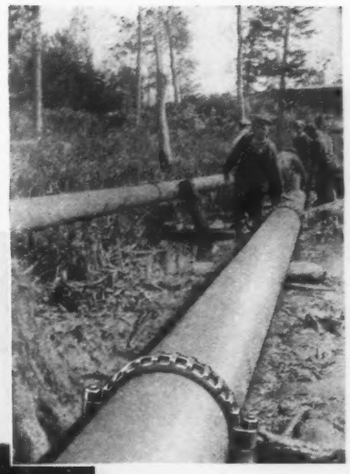
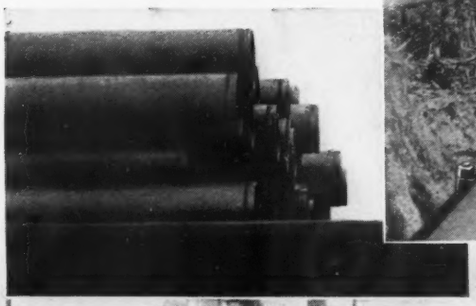
"FOR EVERY JOINT... ON THE LINE"



12' oil line with Victaulic Couplings laid over yielding, swampy ground

Grooved pipe for Victaulic Couplings as easy to ship as plain end pipe



Train-load of 6" pipe, grooved for Victaulic Couplings, South Chester Tube Company, Chester, Pa.

VICTAULIC COUPLINGS

TWENTY-NINE carloads of six inch pipe leaving the South Chester Tube Company, of Chester, Pennsylvania, for the oilfields—a thirty-two mile high pressure oil line—every length grooved for Victaulic Couplings.

In the world's oilfields Victaulic Couplings have earned standardization by the leading oil producing and refining companies for these reasons:

First: Victaulic Couplings provide leak-proof lines for crude oil, gas, water and refined products—lines that stay leakproof for the life of the pipe—at vacuum and up to all working pressures.

Second: Victaulic Couplings enable lines to be laid faster and at less labor cost, because unskilled, primitive labor can do all the work.

Third: Victaulic Couplings give flexibility at every joint and provide for the contraction and expansion of the lengths of pipe they connect—provide a strain-free line that is not injured by vibration, line sag or even shifting sideways under full working pressure.

Fourth: Victaulic Couplings permit the opening of the line at any joint for repairs or cleaning or for cutting in a branch line—with a minimum interruption of service and without injury to either pipe or coupling.

Fifth: Victaulic Couplings and Fittings are available for all sizes of steel, spiral weld, wrought iron and cast iron pipe in all sizes from ¾ inch up—for any pressure.

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CASE HARDENING SERVICE COMPANY
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VICTAULIC COMPANY OF AMERICA
26 Broadway New York

All-purpose pipe couplings

"For every joint on the line"

FLEXIBLE LEAK-PROOF
VICTAULIC
REG. U.S. PAT. OFF.
PIPE COUPLINGS

For detailed information on uses, users, installations, sizes, prices—write or mail this coupon.

VICTAULIC COMPANY OF AMERICA
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Please send Victaulic Bulletin No. 5.

Name .....

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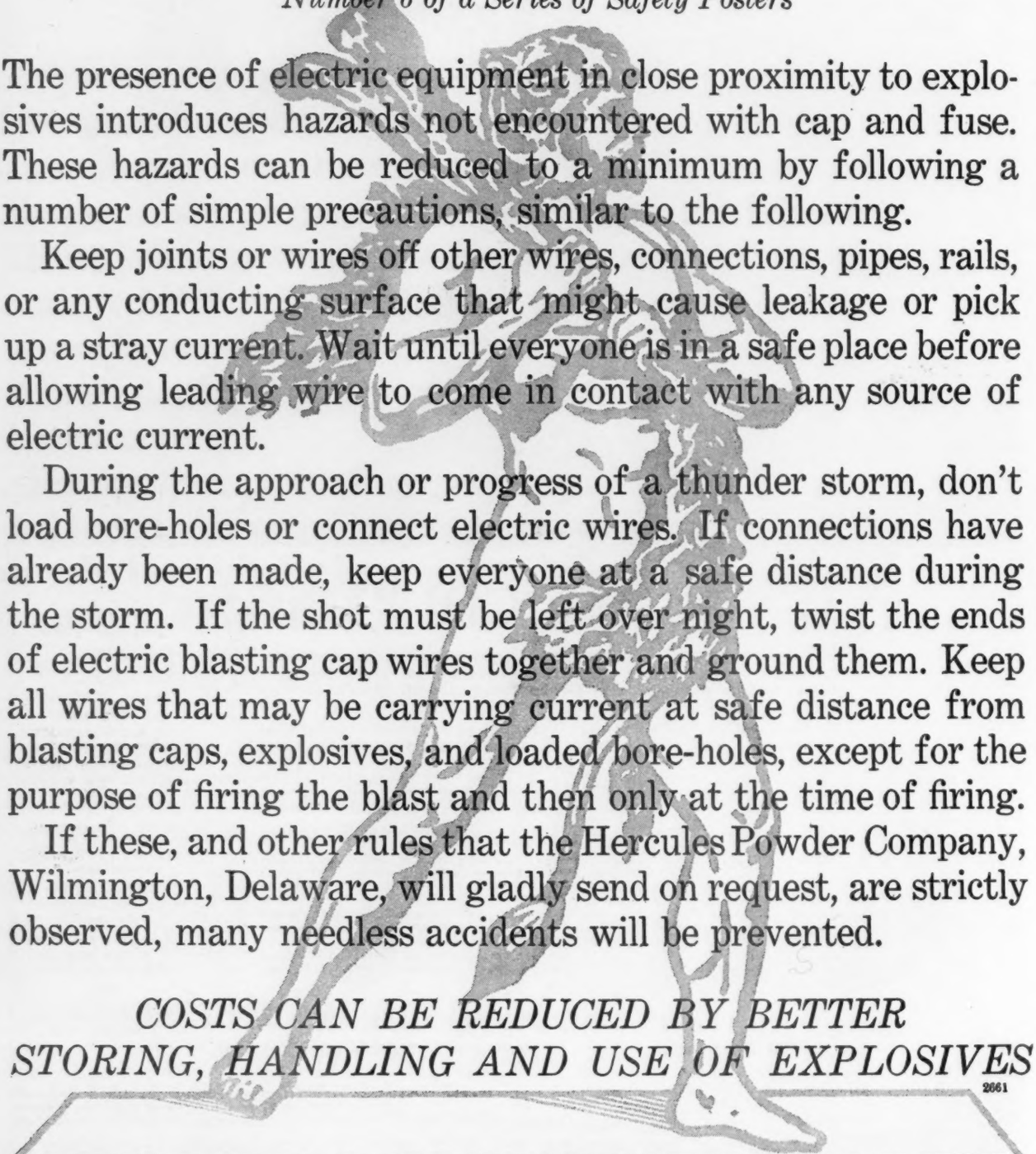
FOR CRUDE OIL, GAS, WATER, SEWAGE, COMPRESSED AIR, ETC.

PRECAUTIONS IN HANDLING ELECTRIC EQUIPMENT FOR BLASTING

Number 6 of a Series of Safety Posters



The presence of electric equipment in close proximity to explosives introduces hazards not encountered with cap and fuse. These hazards can be reduced to a minimum by following a number of simple precautions, similar to the following.

Keep joints or wires off other wires, connections, pipes, rails, or any conducting surface that might cause leakage or pick up a stray current. Wait until everyone is in a safe place before allowing leading wire to come in contact with any source of electric current.

During the approach or progress of a thunder storm, don't load bore-holes or connect electric wires. If connections have already been made, keep everyone at a safe distance during the storm. If the shot must be left over night, twist the ends of electric blasting cap wires together and ground them. Keep all wires that may be carrying current at safe distance from blasting caps, explosives, and loaded bore-holes, except for the purpose of firing the blast and then only at the time of firing.

If these, and other rules that the Hercules Powder Company, Wilmington, Delaware, will gladly send on request, are strictly observed, many needless accidents will be prevented.

COSTS CAN BE REDUCED BY BETTER STORING, HANDLING AND USE OF EXPLOSIVES

2661

HERCULES POWDER COMPANY, (INCORPORATED) 932 King Street, Wilmington Delaware

Gentlemen: Please send me the following: ☐ Large linen poster of explosives handling and use rules. ☐ Best Practices Handbook.

☐ Other advertisements of this series which are suitable for bulletin board posting. ☐ 1928 *Explosives Engineer* index of drilling and blasting articles.

Name.....Company.....Address.....

Cutting Coal Cutting Costs

The R-47 "RADIALAXE" Coal Cutter

THE Radialaxe Coal Cutter, made in Canada, and used the world over, will perform a wide variety of work.

It will drive entries, overcut, undercut, shear, and work out clay bands. At one set-up of the column, a band 12 feet wide by 8 feet deep can be cut out.

The "Radialaxe" is comparatively light in weight and simple in construction, with few parts, all of which are renewable. It is easy to operate, is powerful, economical on air, and costs remarkably little for upkeep. Wherever coal is mined the world over, these machines are widely used.

Tear out the coupon at the left. Send it to us. It will bring you Bulletin K-400-A, fully describing and illustrating the Radialaxe Coal Cutter.

Canadian Ingersoll-Rand Company, Limited
10 Phillips Square
Montreal, Canada

Please send us a copy of Bulletin K-400-A, which describes the R-47 Radialaxe Coal Cutter.

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CANADIAN INGERSOLL-RAND COMPANY LIMITED
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Associate offices the world over

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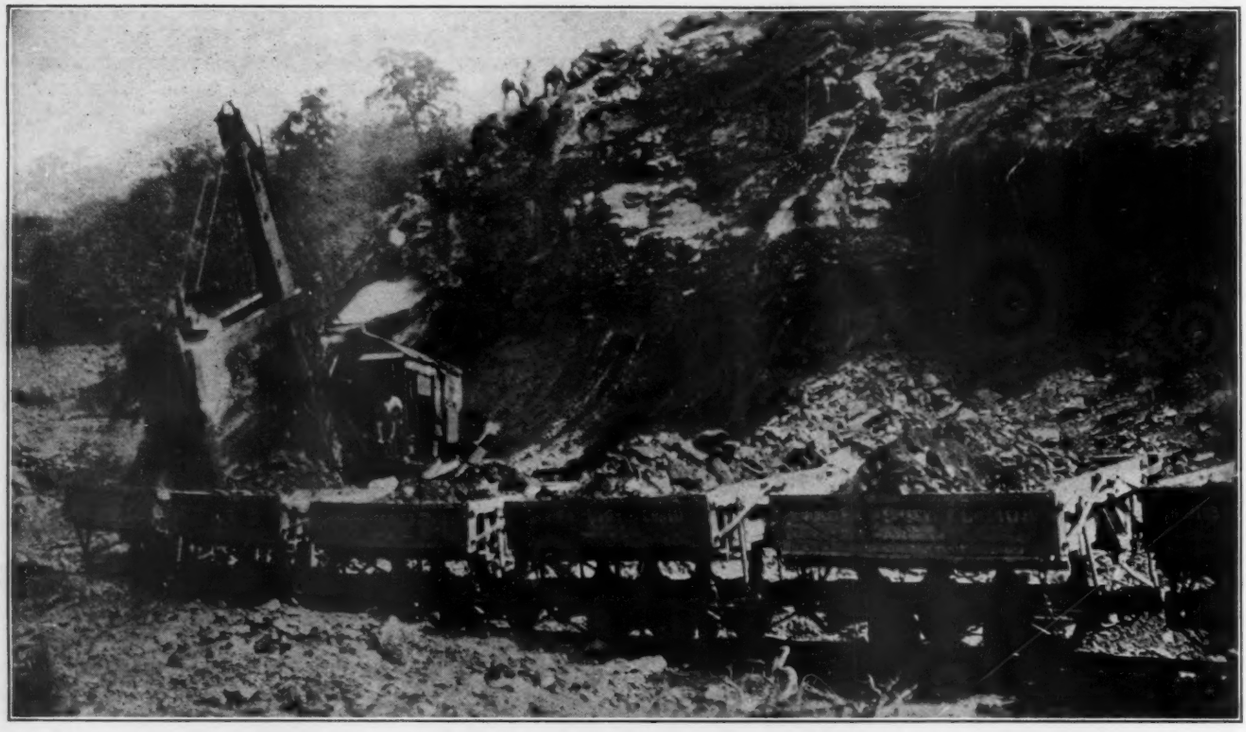
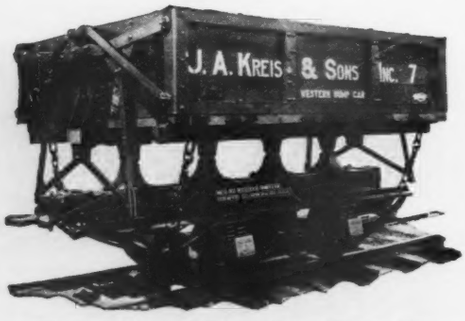


One of John H. Casey Company's trains of Western 4-yard dump cars at the big cut. Saw Mill Run Boulevard work, Pittsburgh.

Yes, They Are Westerns



Western 5-yard Heavy Duty Dump Car

WHEN the work is heavy no dump cars but Westerns seem to fill the bill. The $200,000 rock cut in the picture is 700 feet long and 4-yard Westerns are handling the rock.

Strength, dependability and quick dumping are needed in heavy work. And when the 380,000 cubic yards of rock and earth involved in those three miles of Pittsburgh boulevard construction have been moved, the Western Dump Cars will be ready for another big job, practically as good as new.

May we explain in detail why Western 4-yard cars are installed on so many big construction jobs requiring narrow gauge dump car equipment?

Write today for the facts.

Western Wheeled Scraper Company
Aurora, Illinois, U. S. A.

WESTERN

DUMP CARS AND GRADING EQUIPMENT

IT STOPS *these* WASTES!

You can't jack up prices, for that would give competitors the business. So—if you wish to increase profits—wastes must be eliminated and operating costs hammered down.

Protectomotor Air Filters do away with the high cost of dirty air. They take dust-filled, grit-laden air and remove 999 of every 1,000 particles of dust. It is a proven fact that these filters will—

1. Reduce 75 to 85% of the wear on cylinders, pistons, bearings, valves and other moving parts of compressors, Diesel engines and any equipment operated by compressed air.

2. Cut down carbon deposits 60 to 70%—making it unnecessary to clean valves for about one year, instead of every thirty days or so.

3. Enable machines to operate from 3 to 5 times longer without overhauling and make them more efficient.

4. Eliminate loss of costly compressed air wasted when valves stick.

5. Reduce oil consumption materially and silence noise.

30 DAYS' FREE TRIAL

Send for a Protectomotor Air Filter on trial. If not convinced in 30 days that it will save you many times its small cost, return it and the trial won't cost you one cent.

Mail the convenient coupon before you forget it.

PROTECTOMOTOR
REG. U.S. PAT. OFF.
99 9/10 Per Cent EFFICIENT
AIR FILTERS

Staynew Filter Corporation
103 N. Water St., Rochester, N. Y.

Please send a copy of your booklet and information about your 30 day free trial offer on a Protectomotor for use on

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IN THE SMALL SHOVEL FIELD

½ to 1¼ CU. YARDS

It is logical to expect that Bucyrus-Erie, world's largest exclusive manufacturers of excavating machinery, would have special facilities for the production of small equipment.

Separate factories, and a separate engineering organization of outstanding ability, are maintained for the sole manufacture of small excavating units — Gas, Diesel, Electric, Gas + Air and Diesel + Air. In addition, this small-unit division is privileged to draw on the sum-total experience of the Bucyrus-Erie organization.

Still more impressive is the fact that Bucyrus-Erie has more machines actually operating in the field than any other manufacturer of excavating machinery. Suitability for the job — and dependability in operation — are traditional features of Bucyrus-Erie shovels, large and small. And Bucyrus-Erie Service extends to every part of the civilized world!

Write for bulletin on the size of equipment you need.

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Plants: South Milwaukee, Wis., Erie, Pa., Evansville, Ind. General Offices: South Milwaukee, Wis.

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Representatives throughout the U. S. A. Offices and distributors in all principal countries.

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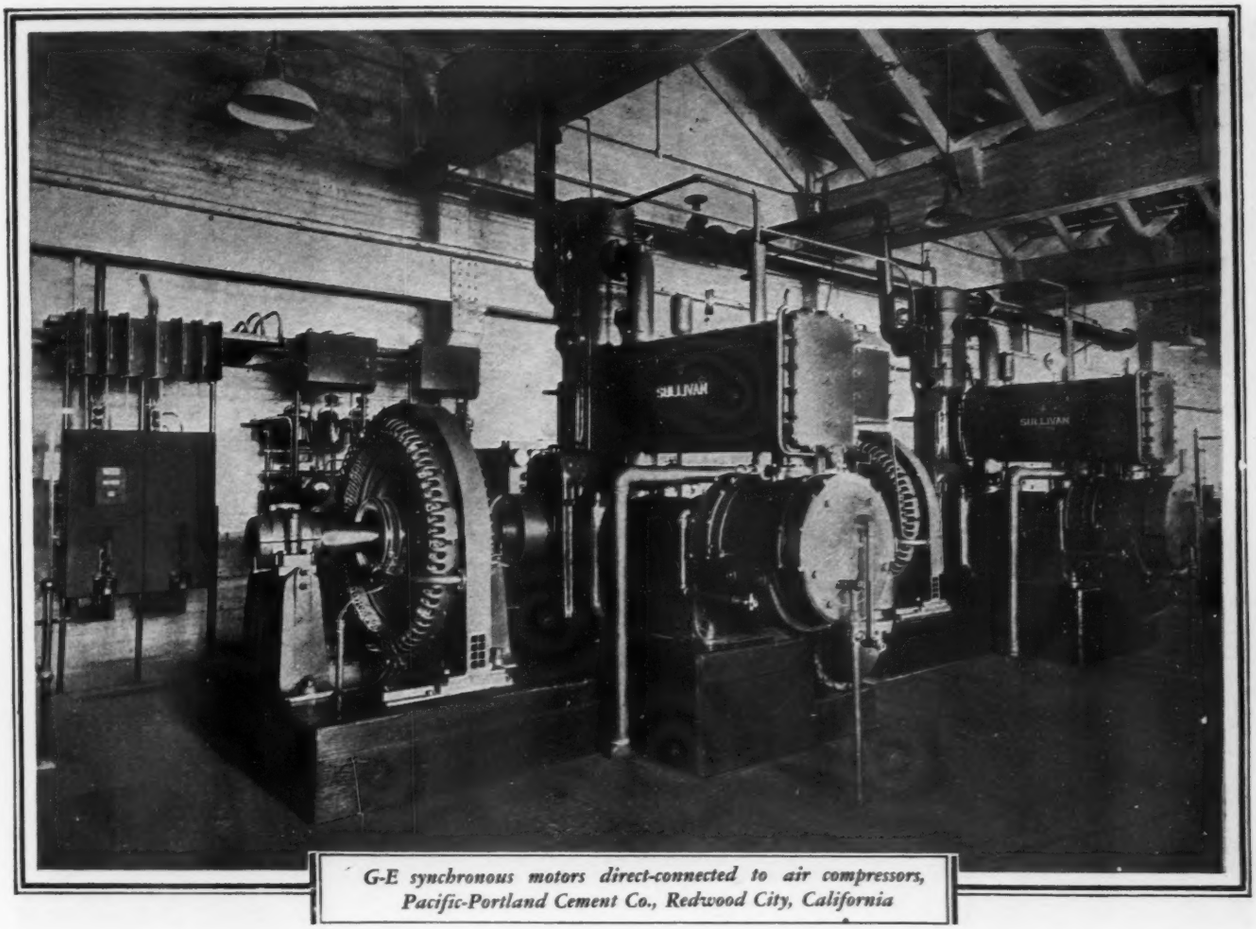

G-E synchronous motors direct-connected to air compressors, Pacific-Portland Cement Co., Redwood City, California

For Large Compressors—
G-E SYNCHRONOUS-MOTOR DRIVE

MORE and more, direct-connected G-E synchronous-motor drive is being used for large compressors.

The reason? Because it is compact—yet easily accessible—highly efficient, and economically maintained. In addition, it improves the power-factor and lowers the power costs of the whole plant.

The nearest G-E office will gladly show you how you can use synchronous-motor drive to lower operating costs.

Motorized Power
—fitted to every need

107-48

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Pneumatic Grinders, Swing Frame Machines and Floor Stands

FOR all types of high speed snagging equipment there are Norton Bakelite bonded wheels with their open structure for cool, fast cutting—wheels that will give maximum production at minimum cost. Norton Bakelite wheels were developed by the Norton research laboratories with their staff of highly trained engineers and produced in the Norton plant with its modern equipment.

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GRINDING WHEELS

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W-275

NORTON PRODUCTS ·· Grinding Machines; Lapping Machines • Grinding Wheels; Abrasives for Polishing; India Oil Stones • Laboratory Ware, Refractories; Porous Plates • Norton Floors–Alundum Tiles & Aggregates

Here's where
TEXACO
hit the hot-plate

The *Hot-Plate Test* Proves It..

TEXACO air compressor lubricants are ***remarkably*** free from carbon forming elements. Their clear golden color is an indication of their purity. Their action on the hot plate is the definite proof.

Try this test. Place a few drops of any of these Texaco lubricants on a smooth metal surface heated to about 700° Fahrenheit. Notice how clean the area when the oil has burned away. Try other compressor oils in the same manner. The dark smudges of carbon show what happens with these oils in the compressor cylinders.

Texaco compressor lubricants (Texaco Spica Oil, Texaco Cetus Oil, Texaco Alcaid Oil and Texaco Algol Oil) eliminate one of the greatest hazards of compressor operation. Their extremely low carbon residue is remarkable.

Call a Texaco Lubrication Engineer and ask him to demonstrate to you the fine qualities of these effective Texaco compressor oils. Ask him to show you the hot plate test. Write the Texas Company.

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THE TEXAS COMPANY
Texaco Petroleum Products

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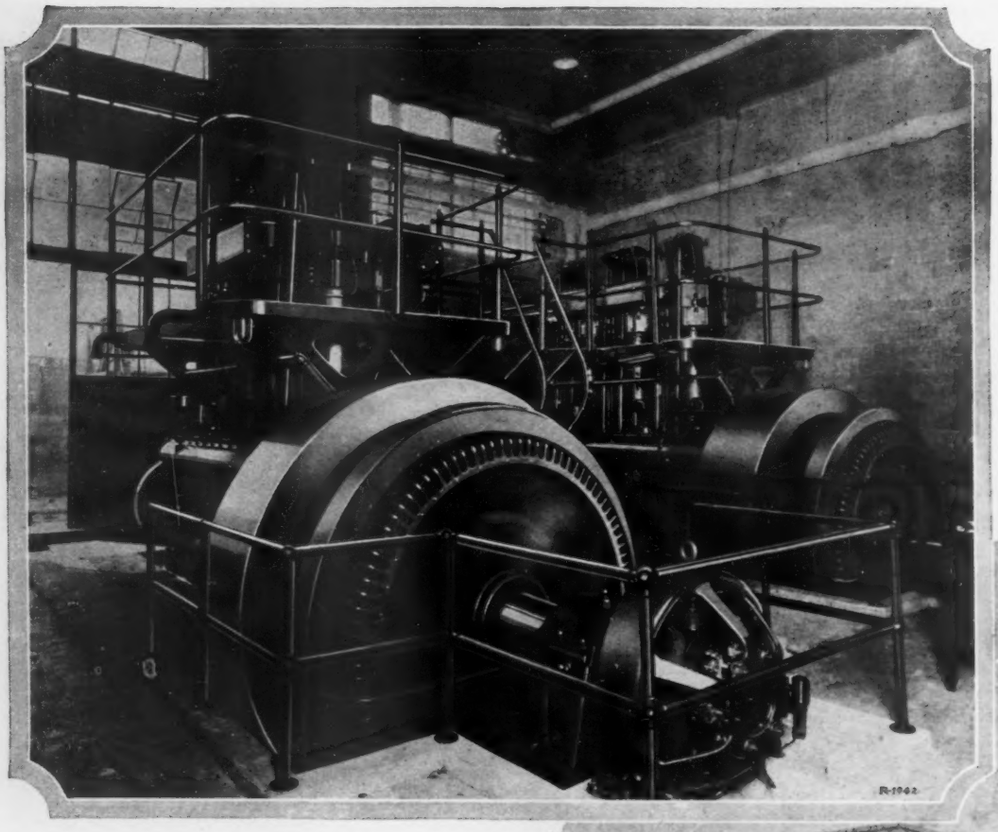
There is a Texaco Lubricant for every purpose



Diesels Furnish Economical Power for Ice Plant

An ice plant, as you know, has a wide variable load factor. Power costs must be kept as low as possible to overcome the disadvantages of this condition.

To minimize the power cost of their new plant, No. 20, The Detroit City Service Company decided on Diesel engines as prime movers. Two Ingersoll-Rand solid-injection Diesel engines were installed.

A year of service has proved the wisdom of this company's decision from the standpoints of both reliability and economy. There was no trouble of any kind during this period. Fuel and lubricating oil costs over the year averaged between five and six mills per kilowatt.

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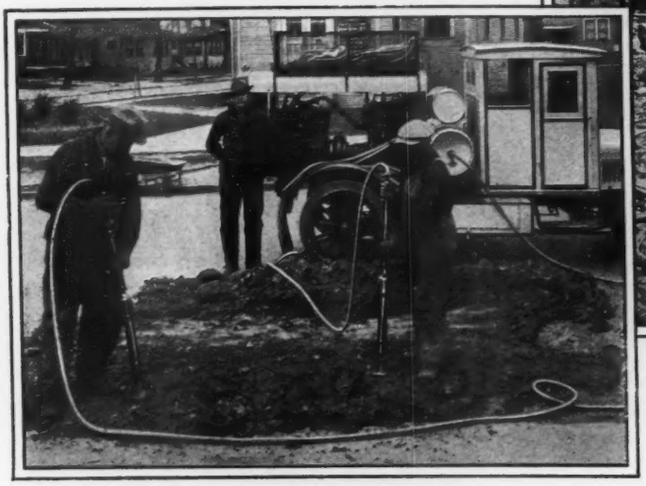
153-SOE

Ingersoll-Rand

At right—Photo shows drills putting snake holes at a trap rock quarry in New York State. Wherever resistance to abrasion is a factor, Goodrich Type 50 (3 braid) air hose is chosen. (Photos courtesy Ingersoll-Rand)



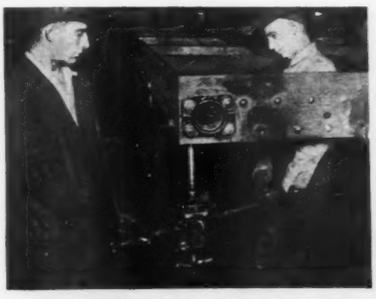
At left—Photo shows workmen ramming in backfill with a portable compressor running the backfill tampers. Superior resistance of Goodrich Type 50 (3 braid) air hose to oil deterioration makes it last longer in this type of service

Two construction features that give this hose greater stamina

MODERN contractors no longer buy hose as "just hose." They figure the cost of hose as a part of the cost of doing business—and this has markedly increased the demand for a hose that meets—and more than meets—modern compressed air and pneumatic tool conditions.

To make a hose that will withstand the strenuous conditions in this type of service—to make a hose that proves itself a thoroughly wise investment—Goodrich saw that a better hose must have two superiorities of construction. Outside, the hose must put up a greater resistance to abrasion. Inside, the hose must have a tube that resists, far longer, the disintegrating effect of oil.

In Type 50 air hose, Goodrich has developed a cover that will not only outwear the ordinary rubber hose of double its thickness, but will also outwear any kind of steel armoring. How important this is, every contractor understands.



A pneumatic drill in operation in a car stop. Durability and improved resistance to kinking make Goodrich Type 50 air hose (2 braid or 3 braid) a popular hose for metal drill grinding, hoist and saw service

Inside, Type 50 air hose possesses a tube that resists the rotting effect of lubricating oil, up to 200 degrees F., *from two to five times longer than ordinary rubber*. As a result, Type 50 air hose materially lowers replacement costs on installations where tools are lubricated through the hose.

Type 50 air hose is well adapted for quarrying service where light weight is desired, as well as for railroad, car building, and general shop service. Many contractors and engineers have found that Type 50 air hose speeds up operations and eliminates frequent replacement costs.

• • •

We will gladly send additional information. Write to The B. F. Goodrich Rubber Co., Est. 1870, Akron, Ohio (In the West, Pacific Goodrich Rubber Co., Los Angeles, Cal.) or fill in the coupon below.

Goodrich

CA-12

THE B. F. GOODRICH RUBBER CO., *Akron, O.*
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Gentlemen: Please send me Catalogue 3485 on Type 50 air hose. This puts me under no obligation.

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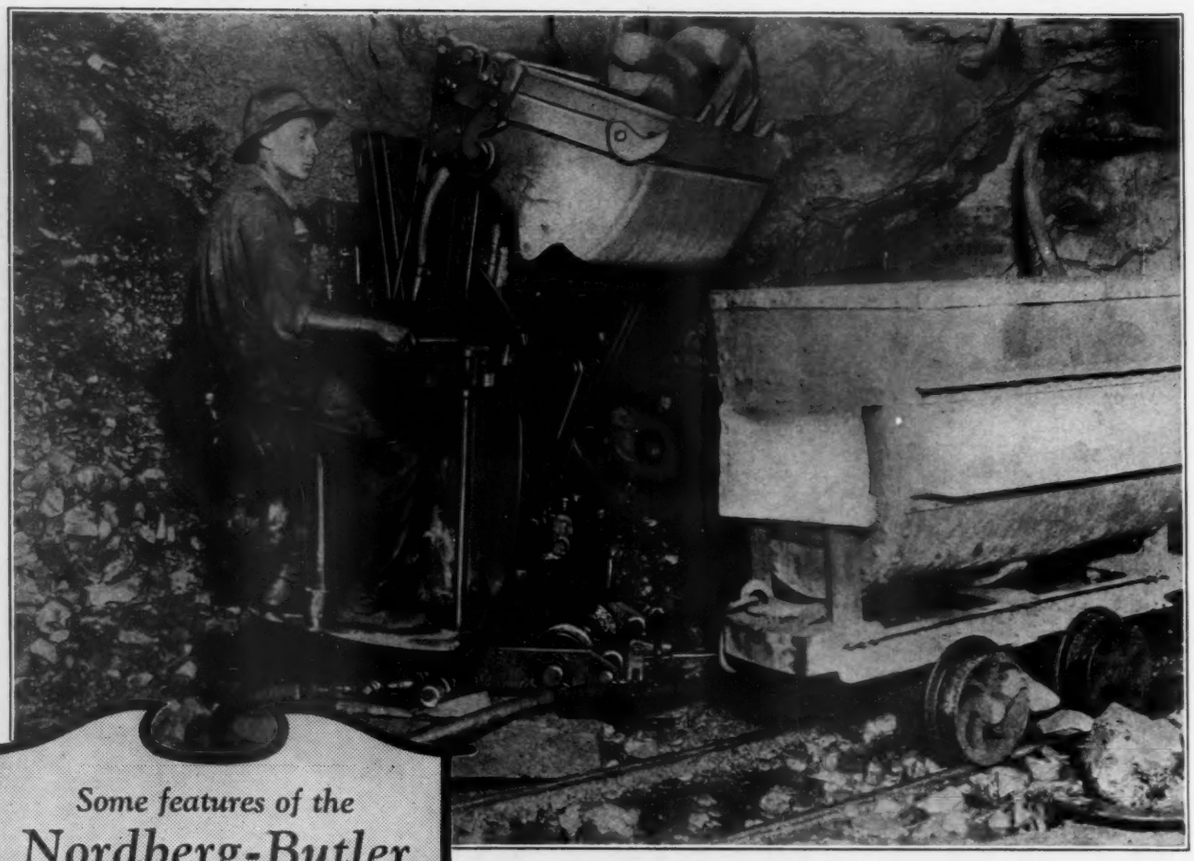

Nordberg-Butler Shovel working in the Pilares Mine of the Moctezuma Copper Co., a Phelps Dodge subsidiary at Nacozari, Sonora, Mexico.

Some features of the

Nordberg-Butler Shovel

Full revolving. Loads cars at either side or behind. Solves the car supply problem.

Will work in drifts as small as 5½ x 7 feet. Has a clean up path of 18 feet.

Built compactly to pass through small openings.

Weighs only 4950 pounds, but built of selected materials so proportioned to withstand severe usage.

On many jobs it is doing the work of larger and more expensive machines.

Has largest dipper for its weight than any shovel built.

Load Muck Mechanically

The present day tendency in all lines of industry is steadily toward a greater use of mechanical equipment. Those who are reducing costs, are replacing hand labor by machinery wherever possible. It is no longer necessary to load ore and rock by hand. The Nordberg-Butler Shovel will lower labor costs and greatly speed up other operations. Here is a dependable machine, whose performance is surprising many of its users.

Let us furnish further particulars of how the Nordberg-Butler Shovel will save you money on drifting and tunneling jobs. Bulletin DR-10 describes it.

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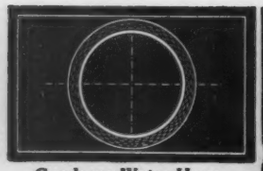
MILWAUKEE, WIS., U. S. A.

NORDBERG



Goodyear Water Hose

Can be run over, dragged over rough floors and sharp edges, banged around corners; built to withstand severe abuse without damage. A superior water hose, strong and flexible. Available in a variety of plies and sizes to withstand all working pressures. Used for innumerable purposes in all industries.

Goodyear Sanitary Hose

A white hose. Built to withstand external action of animal fats, fish oil, fruit acids, and internal effects of hot water, and low-pressure steam. Used for wash-up and sterilizing service in creameries, ice cream plants, packing houses, canneries, bakeries, condenseries, pickle factories, laboratories—standard everywhere in the food industry.

Goodyear Spray Hose

Built of impervious stock to withstand spray chemicals under extremely high pressures. Used to fight injurious insects with copper sulphate, copper carbonate, lead arsenate, and Paris Green. Used in industry to spray lacquers and paints of high turpentine content. Will withstand pressures up to 500 lb. per square inch.

Goodyear Sandblast Hose

A hose that will last longer than iron pipe. Made of pure gum rubber stocks which will resist destructive action of sand blast materials, angular grit, chilled steel shot, and metallic abrasives. Sufficient plies of fabric to hold all working pressures and externally tough for resistance to wear under blast conditions. Used in all industrial finishing processes.

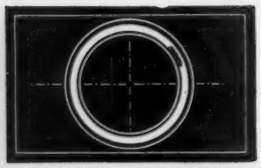
G.T.M. SPECIFIED
GOODYEAR DREDGE SLEEVE
FOR
AMERICAN AGGREGATES CORPORATION
GREENVILLE, OHIO
12 PLY - 24" LONG - 16" DIAMETER

300 Tons of Impact—and the G. T. M.

No ordinary dredge sleeve would hold up to the job of the American Aggregates Corporation, Greenville, Ohio. The G. T. M.—Goodyear Technical Man—saw that instantly. The rubber joints of the 1300' pipeline had to take the full impact of 300 tons of powerfully impelled rock per hour. Twelve-inch boulders, smaller and sharper stuff as well, hurtled destructively and constantly at the bending, yielding pipe joints. ***Only after thorough analysis*** of such factors as these, did the G. T. M. make his expert recommendations. Then he specified 12 ply Goodyear Dredge Sleeves, 24" in length, 16" diameter, tough, adequately flexible, designed for the job.

"Helped to obtain high economies," writes Mr. Fred D. Coppock, President of the American Aggregates Corporation. "We are glad to speak a word of praise for Goodyear Dredge Sleeves, because they have helped us to obtain high economies in plant operations . . . The knowledge of the rubber technicians and the experience of the practical production engineer, combined as they are in your G. T. M. service, have been of very tangible value to us."

Not only dredge sleeves but the various types of special purpose hose outlined in the accompanying diagrams as well as belting and molded rubber goods, are positively specified to their work by the G. T. M. ***For you, also, G. T. M. service has tangible value.*** You may have Goodyear hose or other mechanical rubber goods specified to your own needs or receive detailed information about Goodyear's service to others in your industry by writing to Goodyear, Akron, Ohio, or Los Angeles, California.



Goodyear Suction Hose

Manufactured with a concealed metal re enforcement for sand, water, acid suction, fire-engine use, oil suction and discharge. This hose is built to withstand hardest internal and external abrasion from sand, grit, rock-chunks, anything that can be moved by suction. Resists long continued fire-pump pulsation at forced pressures.

Goodyear Air Hose

The standard air hose. Used in mines and quarries, in building and demolition operations, on drills, hammers, riveters. Highly wear-resisting. Built to withstand internal heat, oil, and pressure, and severe external abrasion. Rubber cover is stronger than wire winding. Used in all industries where compressed air has power application.

Goodyear Welding Hose

For oxy-acetylene and oxy-hydrogen welding and cutting processes. Built to withstand all gas pressures and of non-disintegrative materials to prevent clogging of delicate flame orifice. Corrugated for special resistance to metal abrasion. Will not kink and is hard to flatten. Used in all metal welding and cutting operations.

Goodyear Steam Hose

The successful result of the most trying problem in hose manufacture—hose to withstand the supra-vulcanizing effects of steam. Expansion and contraction controlled by special fabric construction. Will not become hard and brittle. Fortified against pulsation, flexion, and severely abrasive wear.

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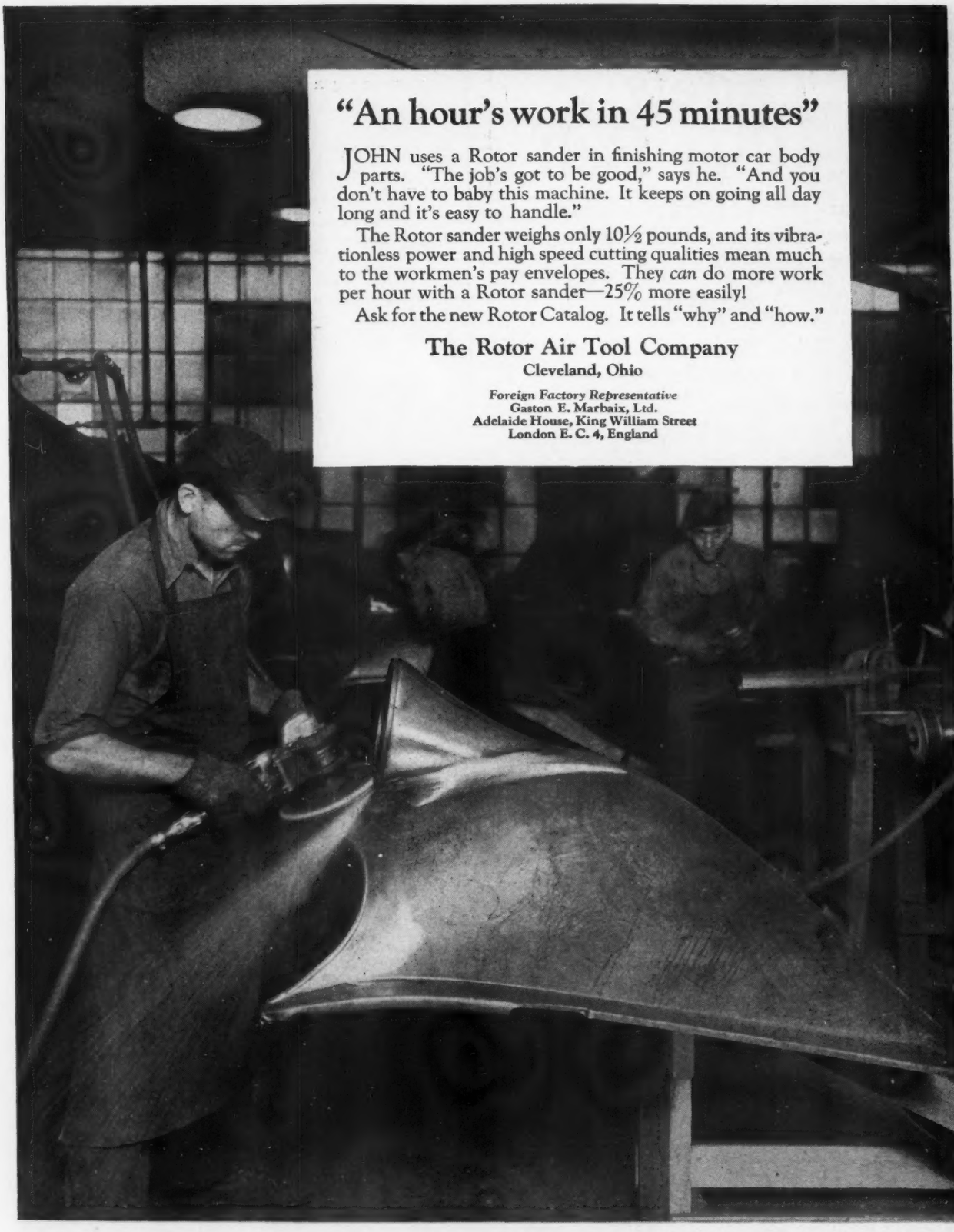

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JOHN uses a Rotor sander in finishing motor car body parts. "The job's got to be good," says he. "And you don't have to baby this machine. It keeps on going all day long and it's easy to handle."

The Rotor sander weighs only 10½ pounds, and its vibrationless power and high speed cutting qualities mean much to the workmen's pay envelopes. They *can* do more work per hour with a Rotor sander—25% more easily!

Ask for the new Rotor Catalog. It tells "why" and "how."

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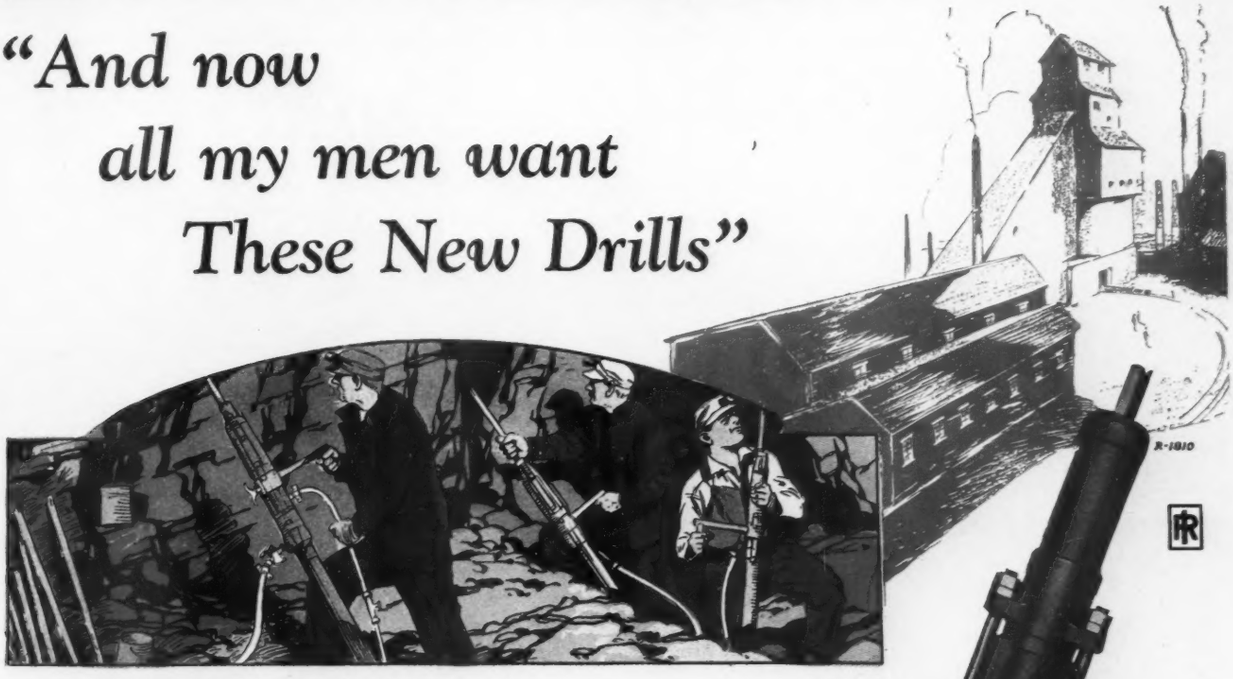

A shift boss of a large Western mine recently said, "We tried out three of your new lightweight stopers with automatic rotation, and now all my men want these new drills."

The situation at his property is similar to that at other mines where the new R-39 and S-49 "Jackstopers" have been in use. The miners "fight" for one of these easy holding, lightweight, powerful machines with positive rifle bar rotation of the Sergeant type.

Standard Ingersoll-Rand air feed with push button control makes it possible to drill in seamy, fitchery ground without fear of sticking the steel.

The R-39 and S-49 "Jackstopers" are modifications of the latest I-R "Jackhamers" with the same symbols.

ESSENTIAL DETAILS

	R-39	S-49
Weight	81-½	85
Bore	2-⅝	2-⅝
Stroke	2	2-½
Total feed travel.	25-⅜	25-⅜
Air Feed	2"	2"

74-SD

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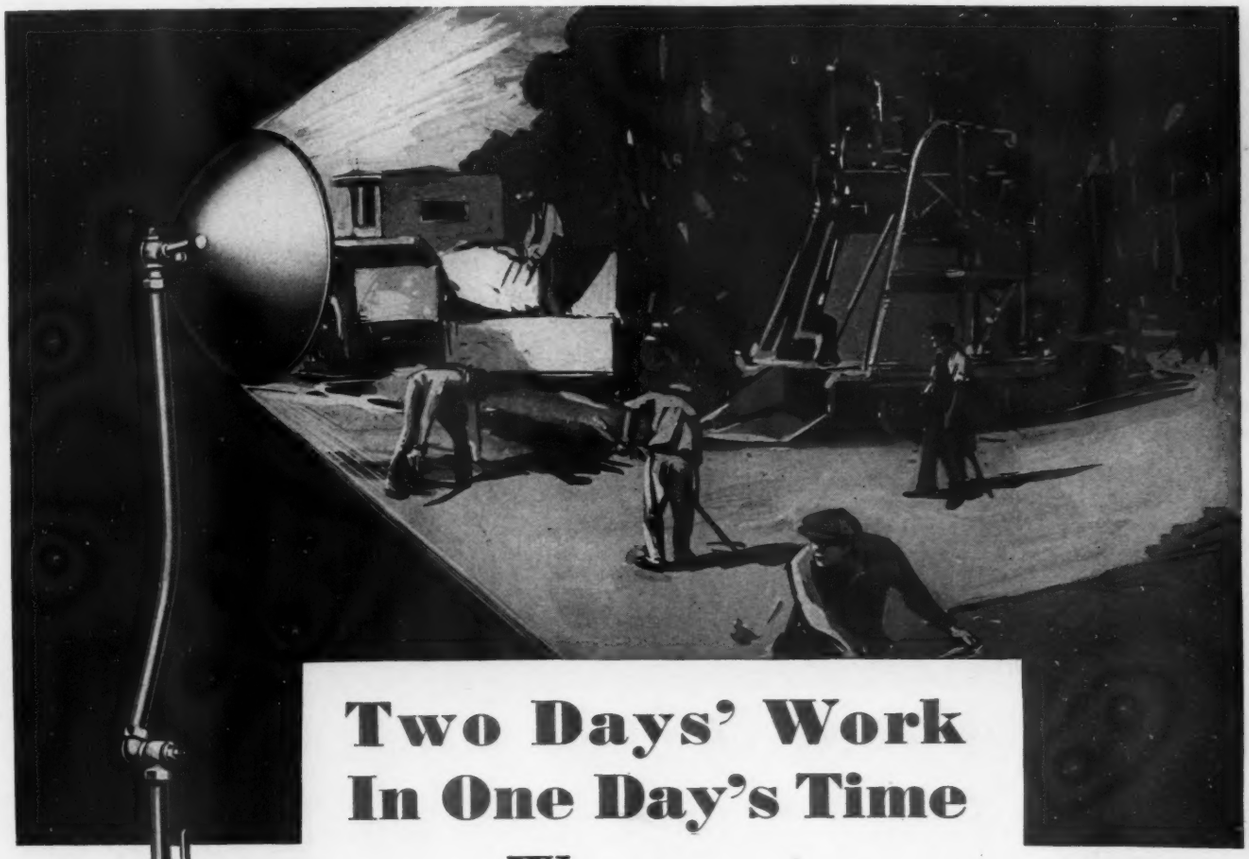

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WHEN days grow shorter—when dark hours crowd out productive operation—Speed up your Job with a night shift.

Carbic Flood Lights are powerful, portable units that supply clear white perfectly diffused light. They are rugged pieces of equipment built to serve you night after night.

Carbic Light requires no costly installation. Any inexperienced workman can charge it in a few minutes—and it is ready for hours of continuous service.

Carbic Light costs only a few cents an hour.

Extend Your Working Day With

CARBIC LIGHT

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LOOK inside your compressed air hose if you need evidence of the trouble caused by oil and water in your compressed air. Gast Air Separators remove all oil as well as all moisture and prevent curling, rotting, and failure of air hose. Oil and water ruined 80% of $35,000 worth of air hose for one company in one year. Stop such losses with Gast Separators.

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THIS improved Jenkins Air Gun operates by the "easy curve" lever that fits snugly into the palm of the hand. A slight squeeze sends a hurricane of air into any nook or cranny, blowing out dirt, dust, chips, lint or filings.

The gun saves labor. It saves air. A special air-tight Jenkins Composition Disc, with which the gun is fitted, contacts intimately with the valve seat when the gun closes. The disc, which may be renewed in a moment, if necessary, eliminates regrinding.

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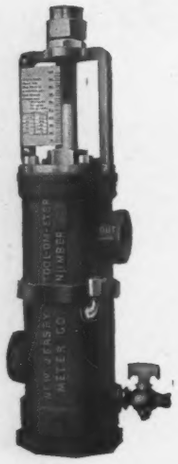

We Specialize

in devices for securing maximum returns from Compressed Air—for "keeping your air pressure UP and your air cost DOWN."

THE TOOL-OM-ETER

shows instantly the flow of air in a pipe or hose, measures the actual air used by any tool, machine or process, substitutes definite information for guesswork in making repairs, maintains equipment in effective working condition throughout its useful life. Ask for Bulletin A-6.

THE NEW JERSEY BLOWER

Transforms a small volume of Compressed Air into a much larger volume of low pressure air.

Type F B (illustrated) for blowing forges and many other purposes. Savings up to 95%.

Type G F B (Gas Furnace Blower) supplies air to gas furnaces and burners. Positive suction overcomes low gas pressure. Saves 90% of compressed air. No moving parts, no maintenance cost, lowest first cost, economical operation.

Bulletin B-2 describes both types.

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Collects and ejects water *automatically*

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PLAINFIELD, N. J., U. S. A.

"Utility" portable Air Hoists

Seven of them on this foundation job, where they handle the buckets in and out of the caissons

Contractors find that Ingersoll-Rand "Utility" Hoists save time and labor on a wide variety of hoisting, hauling, and pulling work.

"Utility" Hoists are portable and can be easily moved about the job and mounted in the most convenient place. They are speedy, powerful, low in air consumption, and safe.

They are made in six sizes, with capacities up to 2000 lbs. pull with single cable.

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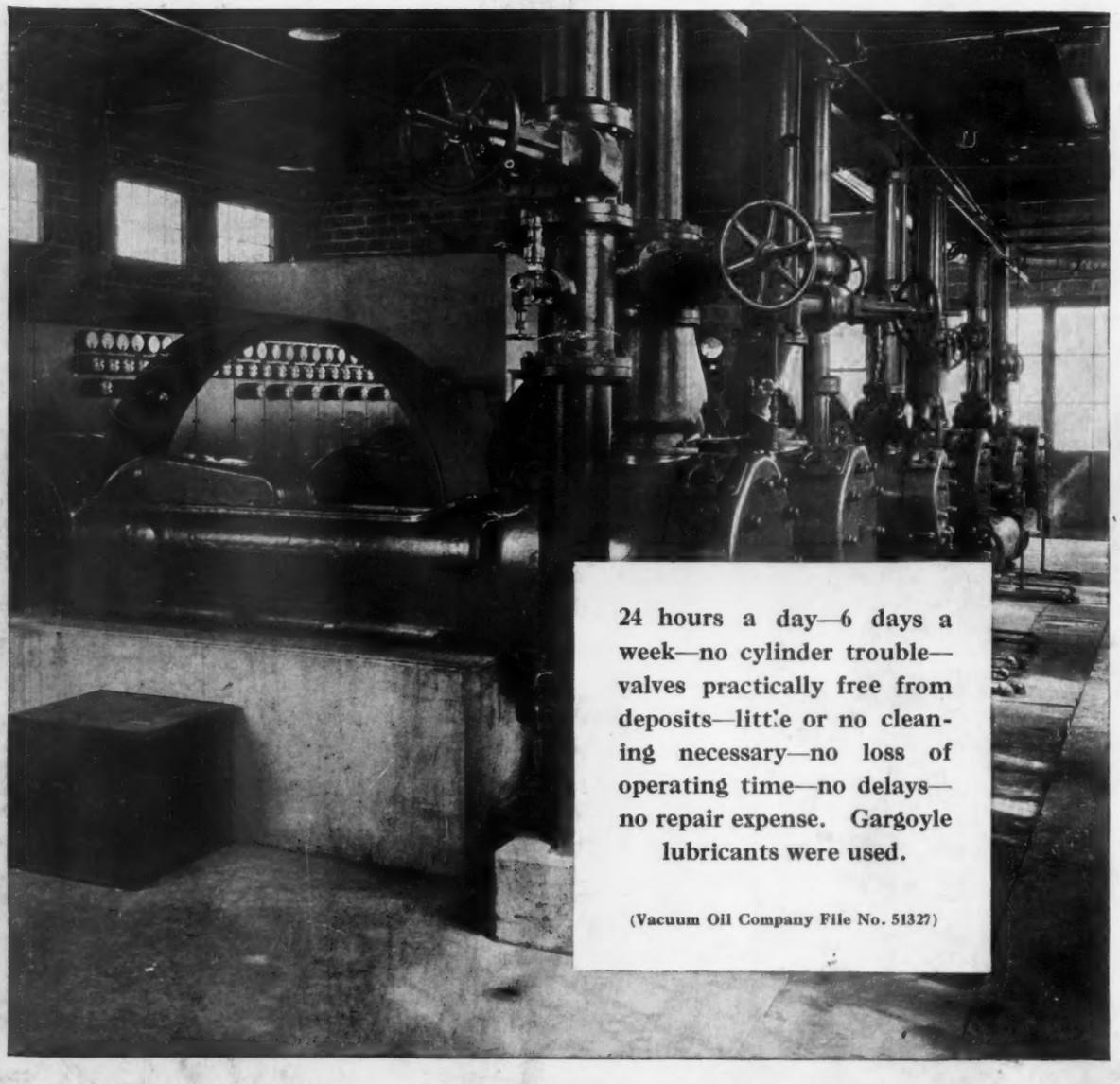
"Utility" Portable Air Hoist

Compressor runs 2 years without trouble

GARGOYLE

Lubricating Oils

The world's quality oils for plant lubrication



24 hours a day—6 days a week—no cylinder trouble—valves practically free from deposits—little or no cleaning necessary—no loss of operating time—no delays—no repair expense. Gargoyle lubricants were used.

(Vacuum Oil Company File No. 51327)

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